Final 2016
Sampling Report
Two-Party Site

Former Building 3564
ADEC Hazard ID. 25015, File No. 108.26.028
Fort Wainwright, Alaska

Contract No. W911KB-16-D-0005
Task Order 3

July 2017

FES
FAIRBANKS ENVIRONMENTAL SERVICES INC.

FINAL 2016 SAMPLING REPORT

TWO-PARTY SITES

Former Building 3564,

Hazard ID 25015, ADEC File ID 108.26.028

FORT WAINWRIGHT GROUNDWATER SAMPLING PROGRAM

Fort Wainwright, Alaska

July 2017

Prepared for

U.S. Army Corps of Engineers, Alaska District

Post Office Box 6898
JBER, Alaska 99506-6898
Contract W911KB-16-D-0005, TO #3

Prepared by

Fairbanks Environmental Services

3538 International Street
Fairbanks, Alaska 99701 (907) 452-1006
FES Project No. 9003-09

TABLE OF CONTENTS

Page Number

FIGURES

TABLES

APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
AFCEE	Air Force Center for Engineering and the Environment
AS	air sparge
bgs	below ground surface
CDQR	Chemical Data Quality Review
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CES	Cost Effective Sampling
CLOSES	Cleanup Operation and Site Exit Strategy
COC	contaminant of concern
DERA	Defense Environmental Restoration Account
DO	dissolved oxygen
DOD	Department of Defense
DRO	diesel range organics
EPA	United States Environmental Protection Agency
FES	Fairbanks Environmental Services Inc.
FFA	Federal Facility Agreement
GIS	geographic information system
GRO	gasoline range organics
IBC	intermediate bulk container
IDW	investigation derived waste
LTMO	Long Term Monitoring Optimization
MAROS	Monitoring and Remediation Optimization System
mg/L	milligrams per liter
µg/L	micrograms per liter
POL	petroleum, oil, and lubricants
QSM	Quality Systems Manual
ROST	Rapid Optical Screening Tool
RRO	residual range organics
SGS	SGS North America Inc.
SOW	statement of work
SVE	soil vapor extraction
TCLP	toxicity characteristic leaching procedure
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
USACE	U.S. Army Corps of Engineers
UST	underground storage tank
VOC	volatile organic compounds

EXECUTIVE SUMMARY

Groundwater samples were collected from 7 monitoring wells at one Two-Party site on Fort Wainwright during August 2016. The following is a summary of the sampling results and recommendations.

Site	Wells Sampled	Analysis	2016 Analytical Results	Recommendations
Former Building 3564 (Hazard ID 25015, ADEC File ID 108.26.028)	AP-7189, AP-7187 AP-7178, AP-6729 AP-7191, AP-7183 MW3564-1	DRO, RRO, dissolve d iron, and sulfate	Five out of seven wells sampled contained DRO above the ADEC cleanup level. Three wells exceeded ADEC cleanup levels for RRO. It is possible that groundwater that came in contact with residual soil contamination with the rise of the water table during 2014and 2016 within the source area, may have caused an increase in contaminant concentrations within and immediately downgradient of the source area that continues to be observed through 2016. The farthest downgradient well, MW3564-1, and well AP-7183, located between the source area and the Building 3559 water well pump house, did not have COC above ADEC cleanup levels. Based on a plume stability evaluation using MAROS software, the mass of the DRO plume has not migrated significantly from the source area.	Continued monitoring of these wells in 2017 for analysis of DRO and RRO.

1.0 INTRODUCTION

This report presents results of the groundwater sampling event conducted at the Two-Party site, Former Building 3564, on Fort Wainwright, Alaska during August 2016. Fairbanks Environmental Services (FES) is providing this service under contract to the U.S. Army Corps of Engineers (USACE), Contract Number W911KB-12-D-0001. The work was guided by the 2016 *Postwide Work Plan* (FES, 2016a), the Postwide Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP; FES, 2016b), and the Statement of Work (SOW) (USACE, 2015).

1.1 Project Overview and Monitoring Report Organization

The purpose of the 2016 sampling effort was to provide current data on groundwater contaminant concentrations for the Former Building 3564 site at Fort Wainwright. The data collected are compared to historical data to evaluate trends in contaminant attenuation over time. A description of the procedures and results associated with these activities are presented in the following sections:

- Section 2 – Investigation Methods
- Section 3 – Former Building 3564 Groundwater Monitoring Results and Discussion
- Section 4 – References

Supporting information can be found in the appendices listed below. Additional information not provided in hard copy, such as laboratory reports, are provided in the Supplemental Information folder on the compact disc accompanying this report.

- Appendix A – Groundwater Sampling Forms and Field Notes
- Appendix B – Chemical Data Quality Review and ADEC Laboratory Data Review Checklists
- Appendix C – Groundwater Sample Summary and Analytical Result Tables
- Appendix D – Monitoring and Remediation Optimization System (MAROS) software and Mann-Kendall Trend Analysis Results

1.2 Project Location and Background

The Two-Party sites are located on Fort Wainwright, Alaska. Fort Wainwright is located on the eastern edge of Fairbanks, within the Fairbanks North Star Borough, in interior Alaska. The 911,604 acre site (as identified in the FFA) includes the main Post area, a range complex, and two maneuver areas. The Former Building 3564 site is located on the Main Cantonment Area of Fort Wainwright. Figure 1-1 presents the site location map.

Fort Wainwright was originally established in 1938 as a cold weather testing station. Currently, primary missions include training of infantry soldiers in the Arctic environment, testing of equipment in Arctic conditions, preparation of troops for defense of the Pacific Rim, and preparation of rapid deployment of troops worldwide. In 2001, Fort Wainwright was selected as the home for third Stryker Brigade Combat Team. Fort Wainwright's mission is to deploy combat ready forces to support joint military operations worldwide and serve as the Joint Force Land Component Command to support Joint Task Force Alaska

Fort Wainwright is located in the interior of Alaska within the Tanana and Chena River drainage basins. The area is subject to extreme seasonal temperature variations and light precipitation (approximately 11 inches).

The aquifer material beneath Fort Wainwright is Chena alluvium consisting of sands and sand and gravel mixtures.These deposits are up to 400 feet thick (to bedrock), and are overlain by silt in some areas. Vadose-zone moisture contents are commonly 2 to 9 percent by weight. Regional groundwater flow south of the Chena River is to the northwest.

Vehicle maintenance operations, fuel storage, and fuel transferring that support troop operations at Fort Wainwright have caused past releases of petroleum hydrocarbons at the Two-Party site discussed in this report. Continued monitoring of this location is part of the Fort Wainwright groundwater sampling program.

1.3 Site Description Building 3564 (Hazard ID 25015, ADEC File ID 108.26.028)

The location of the Former Building 3564 site is shown on Figure 1-1. Former Building 3564 was the standby generator plant for the Post between 1954 and 1999. Arctic diesel fuel for the generators was stored in two 25,000-gallon underground storage tanks (USTs) north of Former Building 3564. The northernmost tank had developed holes about 1 to 1½-inch in diameter from which an unknown quantity of arctic diesel fuel leaked to the groundwater. USTs at Building 3564 were removed in 1994 (Oil Spill Technology, 1994). A release investigation conducted in 1994 found diesel range organics (DRO), gasoline range organics (GRO), and benzene in groundwater (Hart Crowser, 1997). A former leach pit was also located on the north side of Former Building 3564. The pit was connected to a sump pump beneath a diesel generator in Former Building 3564. Water mixed with diesel fuel, lubricating oil, and antifreeze was pumped into the leach pit. Air sparge (AS)/soil vapor extraction (SVE) was approved as the corrective action at the site (CH2MHill, 1996) and a AS/SVE system was installed at this site in 1996 and operated until 1998. The AS/SVE system was removed in October 2002. Additionally, a study was conducted in 1997 to demonstrate the applicability of intrinsic remediation that would work in concert with the AS/SVE system (CH2MHILL 1997). Groundwater monitoring has been conducted at the site since 1996; annual sampling has been conducted at this site since 1999, partly due to the proximity of the site to the Post drinking water well.

1.4 Regulatory Considerations

The following groundwater cleanup levels are the most significant regulations that apply to the Fort Wainwright site sampled under this contract:

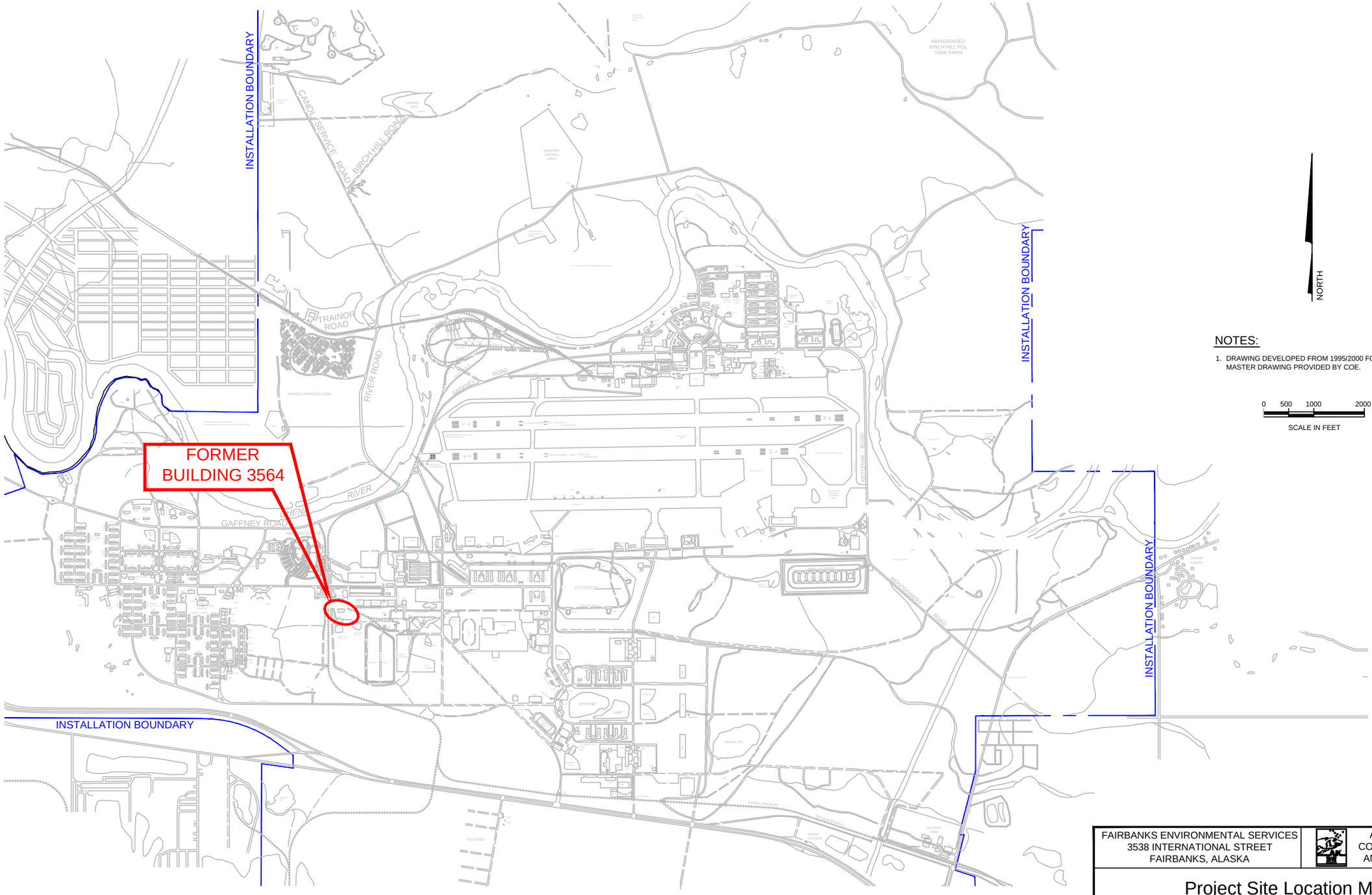
- State cleanup levels are relevant and appropriate for groundwater that is a potential drinking water source (Title 18, Section 75.345, of the Alaska Administrative Code [AAC]; ADEC, 2016a). This section of 18 AAC 75 contains Table C, *Groundwater Cleanup Levels*, which sets cleanup levels for groundwater.

In this report, the term "cleanup level" refers to these State of Alaska regulations. Groundwater cleanup levels applicable for the sites that were sampled are summarized in Table 1-1.

Table 1-1 – Groundwater Contaminants of Concern

Contaminants of Concern	ADEC Cleanup Level (µg/L)	Reference
Residual Range Organic (RRO) Compounds	1,100	18 AAC 75.345,Table C
Diesel Range Organic (DRO) Compounds	1,500	18 AAC 75.345,Table C
Gasoline Range Organics (GRO) Compounds	2,200	18 AAC 75.345,Table C
Benzene	5	18 AAC 75.345,Table C

µg/L – micrograms per liter



NORTH

NOTES:

1. DRAWING DEVELOPED FROM 1995/2000 FORT WAINWRIGHT MASTER DRAWING PROVIDED BY COE.

0 500 1000 2000

SCALE IN FEET

FAIRBANKS ENVIRONMENTAL SERVICES 3538 INTERNATIONAL STREET FAIRBANKS, ALASKA	ALASKA DISTRICT CORPS OF ENGINEERS ANCHORAGE, ALASKA

Project Site Location Map

2016 Sampling Report
Two Party Sites
Fort Wainwright, Alaska

CONTRACT:	FIGURE:	DATE:
W911KB-16-D-0005	1-1	7/17

2.0 SAMPLING PROGRAM

Groundwater sampling was conducted on August 19, 2016. Groundwater samples were collected from seven monitoring wells at the Former Building 3564 site on Fort Wainwright, Alaska.

2.1 Groundwater Sampling and Analysis

Groundwater monitoring wells were sampled to assess contaminant trends over time. Techniques used to purge and sample groundwater were consistent with low-flow sampling methodology (Puls and Barcelona, 1996). This method was developed by the U.S. Environmental Protection Agency (EPA) and allows for faster stabilization of geochemical parameters while purging, due to the decreased agitation of the groundwater. Groundwater samples were collected with variable-speed submersible pumps, using dedicated Teflon-lined tubing at each monitoring well, and groundwater met the stabilization criteria identified in the ADEC *Field Sampling Guidance* (ADEC, 2016b) prior to sample collection.

Groundwater parameters were measured with a handheld YSI multiparameter instrument connected to a flow-through cell. Measured parameters included pH, temperature, specific conductivity, dissolved oxygen (DO) concentration, and oxidation/reduction potential. Turbidity was also measured using an Oakton turbidity meter. When the parameters stabilized, the flow-through cell was disconnected and samples were collected using the pump set at a low-flow rate. Field parameters were recorded on standard groundwater forms presented in Appendix A and are summarized on Table A-1.

Groundwater samples were submitted for the following contaminant analysis: DRO by Alaska Method AK 102 and RRO by Alaska Method AK 103. To allow evaluation of groundwater geochemical changes resulting from biodegradation processes, groundwater samples were also submitted for laboratory analysis of dissolved (field-filtered) iron and sulfate by EPA Methods 6020A and 300.0, respectively. All project and quality control samples were analyzed by SGS of Anchorage, Alaska.

2.1.1 Former Building 3564 (Hazard ID 25015, ADEC File ID 108.26.028)

The seven wells listed below were sampled at Former Building 3564 on August 19, 2016. Groundwater samples were submitted for laboratory analysis of DRO, RRO, iron, and sulfate. Groundwater sampling activities at the Former Building 3564 site are discussed in Section 3.0.

AP-7189	AP-7187	AP-7178	AP-6729
AP-7191	AP-7183	MW3564-1	

2.2 Groundwater Sample Data Quality

The Former Building 3564 groundwater data were reviewed in order to assess whether analytical data met data quality objectives and were acceptable for use. The project data were reviewed for deviations to the requirements presented in the Postwide Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP; FES, 2016), the ADEC Technical Memorandum 06-002 (ADEC, 2009), and the Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (QSM), Version 5.0 (DoD, 2013).

Several results were qualified as potential estimates during the data review process; however, no data were rejected. In all cases, the impact to the overall project due to the data qualifications was minor. The specific data quality issues found during the review are presented in the Chemical Data Quality Review (CDQR) and ADEC Laboratory Data Review Checklist in Appendix B. The reviewed data are presented in Appendix C, and are used in tables and figures throughout the report.

2.3 Investigation-Derived Waste Handling and Disposal

Investigation-derived waste (IDW) generated during Two Party field activities in 2016 included purge water and general refuse (disposable tubing, nitrile gloves, etc.) from monitoring well sampling activities. All IDW and other waste streams were managed according to the procedures outlined in the UFP-QAPP (FES, 2016b).

Purge water was containerized at the time of sampling in 15-gallon polyethylene drums. The drums were labeled with a unique ID and a form was completed documenting the ID and purge volume from each well. The drums were taken to the Fort Wainwright Defense Environmental Restoration Account (DERA) building for temporary storage. The purge water was characterized using the results from individual wells and a separate toxicity characteristic leaching procedure (TCLP) analysis, and disposed of as petroleum water by NRC Alaska at their facility in Anchorage, Alaska. The disposal was conducted in accordance with their permit with the Anchorage Water and Wastewater Utility. The work was completed as part of a separate task in the scope of work for the Fort Wainwright contract, and copies of the manifest and sampling results will be included the 2016 IDW Technical Memorandum (anticipated in spring 2017).

2.4 Institutional Controls

Institutional Control (IC) inspections were conducted at Former Building 3564 on September 9, 2016. The purpose of the inspection is to ensure that the IC's are being met. The following are the site-specific ICs:

- Prevent unauthorized soil disturbing activities to a depth more than six inches below ground surface (bgs)

- Prevent installation of wells for drinking water purposes
- Prevent use of groundwater except for monitoring and remediation activities
- Protect existing monitoring wells

The results of the IC survey are presented in the 2016 Annual Institutional Controls Report (anticipated in 2017) and summarized in Section 4.0.

3.0 FORMER BUILDING 3564 GROUNDWATER MONITORING RESULTS AND DISCUSSION

This section presents the 2016 groundwater monitoring results for the Former Building 3564 site. Groundwater monitoring was completed in accordance with the 2016 Postwide Work Plan (FES, 2016a) and Uniform Federal Policy- Quality Assurance Project Plan (UFP-QAPP) (FES, 2016b).

3.1 Groundwater Elevations

Groundwater elevation data were collected prior to sampling each well during the 2016 sampling event. A comparison of groundwater elevations shows a very slight northwest trend in the groundwater flow direction; however, overall, the groundwater gradient is relatively flat. Well completion data and survey data were not available for MW3564-1. Groundwater levels are shown on Figure 3-1, and Table 3-1 presents groundwater elevations. The elevation data show that the water levels were approximately 3.5 feet higher in August 2016 than in July 2015, and were comparable to water levels measured at the site in July 2014. Groundwater elevations measured during 2014 and 2016 were at the highest levels measured at the site since they were first recorded in 2001.

3.2 Groundwater Analytical Results

Current and historical contaminants of concern (COC) concentrations are summarized on Figure 3-1. Groundwater samples were submitted for laboratory analysis of DRO, RRO, dissolved iron, and sulfate. Complete analytical results are presented in Appendix C, Table C-2. Well AP-7178 is located within the former AS/SVE treatment area; wells AP-7187, AP-7189, AP-6729, AP-7191, AP-7183, and MW3564-1 are located downgradient of the source area. Five out of seven wells sampled contained DRO in concentrations that exceed the ADEC cleanup level, ranging from 2,240 µg/L to 40,400 µg/L. RRO exceeded the cleanup level in three of the seven wells sampled, ranging from 1,850 µg/L to 2,800 µg/L. Contaminant concentrations in groundwater at the Former Building 3564 monitoring wells exhibited the following characteristics:

DRO in the Source Area Well

- DRO in source area well AP-7178 had been below cleanup levels for two consecutive years (2012 and 2013); however, DRO increased to 6,490 µg/L in 2014 and increased again in 2015 to 31,500 µg/L. The DRO concentration in 2016 was 8,650 µg/L, which is a decrease from the 2015 result, but the concentration remains above cleanup levels. It is likely that the increase in the DRO concentration can be attributed to high water levels that were seen during 2014 and 2016, causing groundwater to come into contact with residual soil contamination normally above the water table.

DRO in Downgradient Wells AP-7187 and AP-7189

- Two of the five wells that exceeded DRO cleanup levels are located immediately downgradient of the source area; AP-7187 and AP-7189.
- The DRO concentration recorded during 2015 in AP-7189 was 53,600 µg/L, which is the highest concentration seen since sampling began in this well in 1996. The DRO concentration decreased in 2016 to 40,400 µg/L, which is comparable to the 2014 result. Overall, DRO potentially has an increasing trend in this well.
- The DRO concentration in well AP-7187, decreased significantly during 2015 and was detected an order of magnitude lower compared to the concentration detected in 2014. However, the DRO concentration of 20,700 µg/L detected in 2016 is comparable to the concentration detected in 2014 when groundwater level measurements are also comparable. DRO concentrations appear to be increasing since sampling began in 1996; however, a trend is not clear due to variable data in this well.

DRO in Additional Downgradient Wells

- DRO in downgradient well AP-7191 had remained at typical concentrations historically observed in this well throughout 2014; however, DRO in this well increased during the 2015 sampling event to 9,630 µg/L, which is the highest concentration seen since sampling began in this well in 1996. The increase in DRO in 2015 indicated an increasing trend in this well; however, the DRO concentration decreased in 2016 to a concentration of 3,950 µg/L, which is comparable to previous years DRO results.
- DRO in AP-6729, located between the source area and the Post water well was above the cleanup level at 2,240 µg/L in 2016. This is a decrease from the 2015 DRO result of 4,440 µg/L, the highest concentration detected in this well since 2004. The 2016 DRO concentration was comparable to results detected in previous years. Due to variable data in this well, a trend is not apparent.
- Downgradient wells, MW3564-1 and AP-7183, had DRO concentrations below the ADEC cleanup level during the 2016 sampling event.

RRO in All Wells

- RRO was above the cleanup level in downgradient wells AP-7187 at 2,430 µg/L, and AP-7189 at 2,800 µg/L, and in source area well AP-7178 at 1,850 µg/L.
- RRO in downgradient well AP-7187 had been below cleanup levels for almost five sampling events (2009 to 2013) then increased to 3,830 µg/L in 2014. RRO was again below the cleanup level in 2015; however RRO increased to 2,430 µg/L in 2016. The increase in RRO during the 2014 and 2016 sampling events was attributed to high water levels, resulting in contact between groundwater and residual soil contamination.

Figures 3-2 and 3-3 below depict DRO concentration changes over time and visual trends in wells where it is typically detected:

Figure 3-2. DRO Concentrations in AP-7178 within the Source Area and AP-7189 Immediately Downgradient

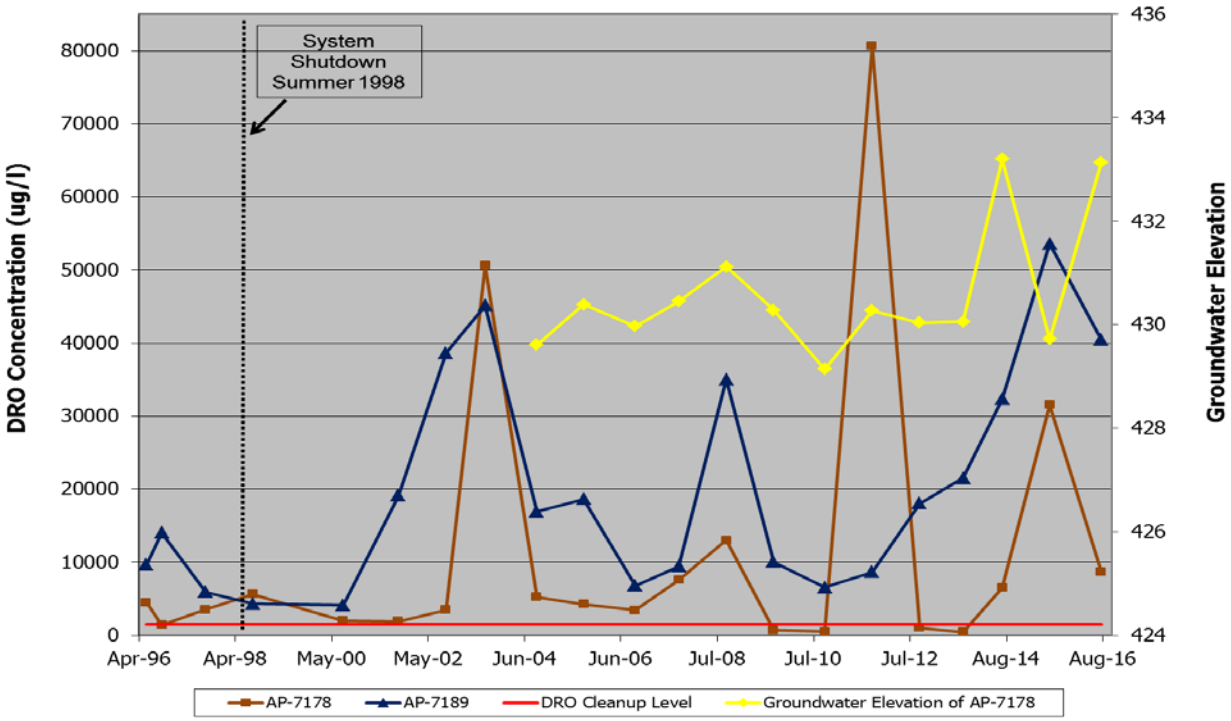
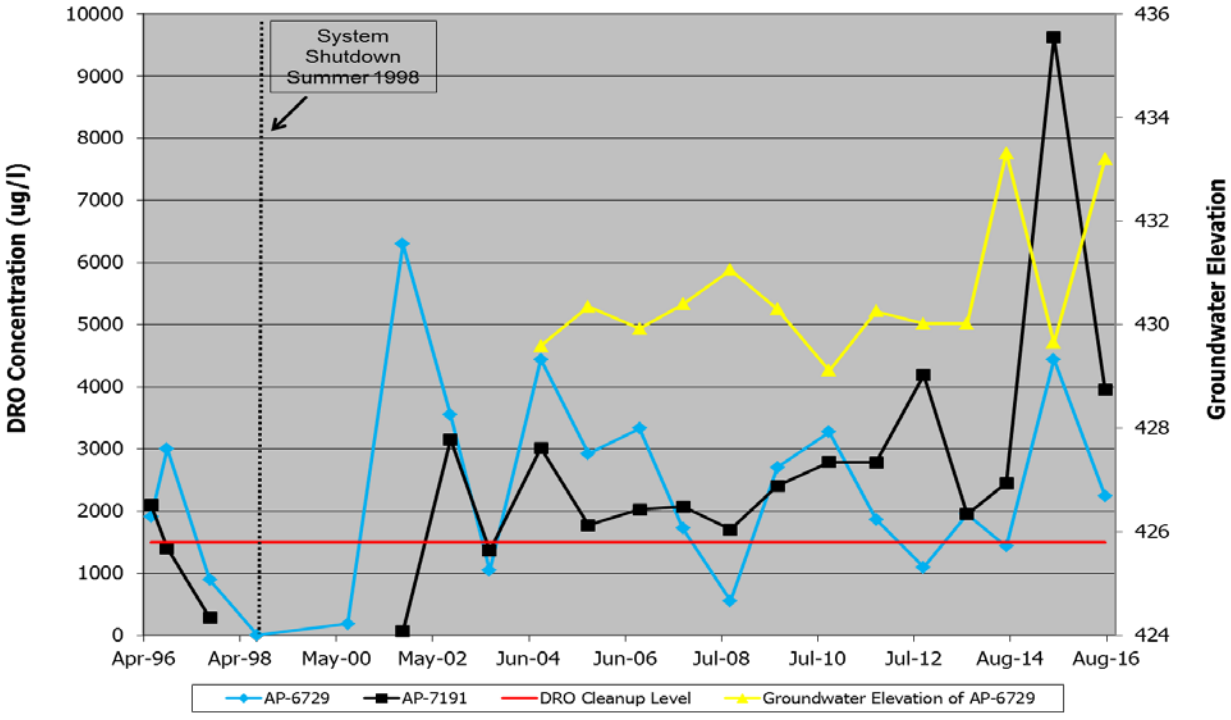


Figure 3-3. DRO Concentrations in Downgradient Wells AP-6729 and AP-7191



3.3 Natural Attenuation Processes

In general, the geochemical sample results are consistent with expected changes resulting from anaerobic biodegradation of hydrocarbons. Wells located within the contaminant plume generally have reduced concentrations of electron acceptors, and increased concentrations of biodegradation byproducts. The following geochemical trends indicate that biodegradation is occurring:

- DO concentrations were between 0.25 and 0.85 milligrams per liter (mg/L) at all well locations, indicating that available oxygen is limited for aerobic biodegradation in these wells. Therefore, anaerobic biodegradation, where ferric iron and sulfate act as electron acceptors, is generally the favorable pathway.
- Background dissolved iron concentrations at Fort Wainwright are typically around 1 mg/L. Dissolved iron in site monitoring wells ranged between 1.59 mg/L and 42.2 mg/L, in all wells except for AP-7183 where it was not detected. All wells except for AP-7183 have dissolved iron concentrations greater than background indicating that iron reduction is occurring at the site.

Background sulfate concentrations at Fort Wainwright are typically around 40 mg/L. Sulfate ranged from 4.58 mg/L to 62.5 mg/L in site monitoring wells. Although sulfate concentrations exceeded the background level in two downgradient wells, sulfate concentrations were well below the background in the source area wells, indicating that sulfate reduction may be occurring at this site.

3.4 Contaminant Concentration Trend and Plume Stability Evaluation

MAROS software was used to evaluate contaminant concentration trends in monitoring wells and plume stability at the Former Building 3564 site. The Air Force Center for Engineering and the Environment (AFCEE) developed the MAROS software (AFCEE, 2006) as a tool to evaluate groundwater data trends and is one among several tools that have been recommended for use in Long Term Monitoring Optimization (LTMO) (EPA, 2005).

Concentration trends for DRO in the individual Former Building 3564 monitoring wells were evaluated for the post-treatment period (1998 through 2016) (results are shown in Appendix D). The results are based on Mann-Kendall trend analysis, and showed that four wells exhibited “No Trend” (result of data variability) (AP-6729, AP-7178, AP-7183, and AP-7187), one well exhibited a “Stable” trend (MW3564-1), one well exhibited a “Potentially Increasing” trend (AP-7189), and one well had an ”Increasing” trend (AP-7191) for DRO.

The Mann-Kendall trend for DRO in source area well AP-7189 was “Potentially Increasing”, due to increasing DRO concentrations since 2010. However, the 2016 result was within the range of concentrations that has been observed in this well, and decreased from the 2015 result. The Mann-Kendall trend in downgradient monitoring well AP-7191 was “Increasing”, although the 2016 result was less than the 2015 result and within the range of concentrations typically

observed. This trend will continue to be evaluated following future sampling events. The DRO trend in the furthest downgradient well, MW3564-1, has remained "Stable", with DRO concentrations well below the DRO cleanup level since sampling began in 2004.

The MAROS software spatial moment analysis was used to evaluate plume stability based on estimated contaminant mass, the trend in the distance from the source to the center of mass, and the trend of plume spread around the center of mass. The DRO plume was evaluated using data between 2006 and 2016 so the analysis could include the same number of wells in each analysis year. The calculated location of the center of mass over time is shown on Figure 3-4, and the moment analysis results are shown on Table D-2 in Appendix D. The analysis showed that the DRO mass exhibited "No Trend", and the distance from the source to the center of mass and spread around the center of mass had "Stable" trends. This is also exhibited on Figure 3-4, which shows the 2016 center of mass location between the maximum from 2010 and minimum from 2011. The plume spread results, as presented as the second moment analysis in Appendix D, also had "Stable" trends.

The MAROS software was also used to evaluate sampling frequency at the Former Building 3564 site (see complete results in Appendix D). Sampling frequency is evaluated within the MAROS software using the Modified Cost Effective Sampling (CES) method. The CES method is based on the rate of change of contaminant concentrations in individual wells relative to the cleanup level. The results of the frequency analysis showed a recommended sampling frequency of biennial for two wells (AP-7183 and MW3564-1), annual for four wells (AP-6729, AP-7178, AP-7187, and AP-7191), and quarterly sampling for AP-7189. The quarterly sampling result was due to the wide range in DRO concentrations that have been observed in this well during recent sampling events.

3.5 Discussion and Recommendations

Annual monitoring for natural attenuation has been conducted at this site since 1999, partly due to the proximity of the site to the Post drinking water well. Groundwater concentration results have showed variability in DRO concentrations, but limited contaminant migration to date. Additional detail regarding contaminant concentration trends in source area and downgradient wells are discussed in the following paragraphs.

Source Area Well AP-7178

One source area well, AP-7178, was sampled during the 2016 monitoring event. It appears that AS/SVE operation (the system was operated between 1996 and 1998) successfully removed benzene concentrations within the source area. Benzene has not been above the ADEC cleanup level since 1996. GRO has never been detected above the cleanup level within the source area. RRO was below the cleanup level between 2005 and 2010, with the exception of a slight exceedance in 2007. RRO analysis was not conducted from 2011 through 2013, and was again below the cleanup level during the 2014 sampling, but increased to above the cleanup level in 2015. DRO in this well decreased to below the cleanup level in 2009 and remained below the

cleanup level until 2013 with the exception of a single significant detection of DRO (80,000 µg/L) in 2011. DRO increased to above the cleanup level in July 2014 and has remained above the cleanup level in July 2015 and August 2016. This increase in DRO concentrations is possibly due to higher than typical groundwater levels in 2014 and again in 2016, causing the groundwater to come in contact with residual soil contamination that is typically above the water table.

Downgradient Wells AP-7187 and AP-7189

Wells AP-7187 and AP-7189 are the closest downgradient wells to the source area. Successful removal of GRO and benzene by the AS/SVE treatment system has prevented further migration of these contaminants to downgradient wells. GRO and benzene have not been above the cleanup level in AP-7187 since 1997. Benzene was detected sporadically in AP-7189, but has been below the cleanup level since 2004. RRO had been below the cleanup level for three consecutive sampling events in AP-7189 (2008 to 2010), and two consecutive sampling events in AP-7187 (2009 and 2010). RRO was detected above the cleanup level in both of these wells in 2014 and in 2016. Natural attenuation appears to be affecting further migration of this contaminant. DRO concentrations remain elevated in these two well locations. The DRO concentration increased significantly during 2015 in AP-7189 to the highest concentration seen since sampling began in this well and only slightly decreased during 2016. In comparison, the DRO concentration in well AP-7187, located approximately 30 feet southeast of AP-7189, decreased significantly during 2015 to the lowest concentration that has ever been detected in this well. However, the DRO concentration in 2016 was comparable to the DRO concentration detected in 2014 in well AP-7187. Due to variability in the data from this well, the concentration trend is considered "No Trend" based on MAROS software analysis.

Additional Downgradient Wells

Two additional downgradient wells, AP-6729 and AP-7191, have exhibited DRO at concentrations that exceed the cleanup level. DRO concentrations in AP-6729 increased during 2015 and then decreased in 2016; however, overall data from this well has been variable and the 2015 trend analysis using MAROS software indicated "No Trend" in this well. DRO in AP-7191 had been relatively stable for many years; however, a recent increase in the DRO concentration has been observed and the trend analysis indicated an "Increasing" trend in this well. The DRO concentration detected in 2015 was the highest concentration detected since sampling this well began in 1996. DRO decreased in 2016 to a concentration comparable to previous years.

The farthest two downgradient wells are MW3564-1 and AP-7183. Well AP-7183 is located in an area between the Post water well pump house (Building 3559) and the site. No COC has ever been detected above the cleanup level in this well. Additionally, the DRO plume does not appear to be migrating based on DRO concentrations in the farthest downgradient well (MW3564-1); remaining below the ADEC cleanup levels and trend analysis that indicates DRO concentrations are "Stable" in this well.

Recommendations

Based on an evaluation of the groundwater data collected annually since 1996, as well as an evaluation of the sampling frequency using MAROS software and the CES method, continued annual sampling at the Former Building 3564 site is recommended. The following seven wells should be sampled once for DRO, RRO, dissolved iron, and sulfate during the fall of 2017.

AP-7178	AP-7187	AP-7189	AP-6729
AP-7183	AP-7191	MW3564-1	

Table 3-1 – Former Building 3564 Groundwater Elevations

Well Number	Total Well Depth (feet btoc)	Top of Casing Elevations[2] (feet MSL)	Water Elevations September 2004[1]	Water Elevations September 2005[1]	Water Elevations October 2006[1]	Water Elevations September 2007[1]	Water Elevations September 2008[1]	Water Elevations September 2009[1]	Water Elevations October 2010[1]	Water Elevations October 2011[1]	Water Elevations October 2012[1]	Water Elevations September 2013[1]	Water Elevations July 2014[1]	Water Elevations July 2015[1]	Water Elevations August 2016[1]
AP-7189	21.8	446.54	429.61	430.39	429.97	430.45	431.12	430.28	429.14	430.27	430.04	430.06	433.2	429.72	433.14
AP-7178	21.33	444.94	429.82	430.35	429.81	430.22	430.35	431.04	429.88	430.84	430.59	430.75	433.98	430.32	433.85
AP-6729	26.5	447.93	429.59	430.35	429.92	430.4	431.06	430.3	429.11	430.26	430.02	430.02	433.32	429.65	433.2
AP-7191	21.73	446.92	429.56	430.25	429.87	430.12	430.72	430.19	428.97	430.11	429.92	429.96	433.04	429.5	433.01
AP-7183	21.7	447.31	429.56	430.28	429.98	430.31	430.93	430.18	429.09	430.11	429.81	429.91	433.19	429.37	433.12
AP-7187	17.9	446.41	429.68	NS	430.03	430.49	431.16	430.28	429.26	430.31	430.06	430.18	433.3	429.72	433.19
MW3564-1	23.43	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

btoc - below top of casing

NA - not available

NM - not measured

[1] Feet above mean sea level (MSL)

[2] Wells were surveyed using Alaska State Plane Coordinate System, NAD83, Zone 3, and Fort Wainwright local grid coordinate system, with elevations recorded in both the NGVD 29 and NAVD88 vertical datum

NORTH

AP-7191	Water Level (BTOC) (feet)	DRO µg/L	RRO µg/L	GRO µg/L	Benzene µg/L
JUN 1996	NR	2,100	NA	150	0.25
OCT 1996	NR	1,400	NA	74	ND (1)
SEP 1997	NR	280	NA	ND (34)	ND (0.1)
AUG 2000	NR	62	NA	ND (100)	ND (2)
OCT 2002	16.18	3,150	ND (1,100)	ND (90)	ND (0.5)
AUG 2003	15.05	1,360	ND (330)	ND (90)	ND (0.5)
SEP 2004	17.36	3,010	704	37.3	0.158
SEP 2005	16.67	1,770	499	ND (90)	ND (0.5)
OCT 2006	17.05	2,020	445	23.8	ND (0.5)
SEP 2007	16.60	2,070	536	20.1	ND (0.5)
SEP 2008	16.00	1,700	190	30	ND (1)
SEP 2009	16.73	2,400	200	NA	NA
OCT 2010	17.95	2,790	518	NA	NA
OCT 2011	16.81	2,780	NA	NA	NA
OCT 2012	17.00	4,190	NA	NA	ND (0.24)
SEP 2013	16.96	1,950	NA	NA	NA
JULY 2014	13.88	2,450	175	NA	NA
JULY 2015	17.42	9,630	837	NA	NA
AUG 2016	13.91	3,950	540	NA	NA

MW3564-1	Water Level (BTOC) (feet)	DRO µg/L	RRO µg/L	GRO µg/L	Benzene µg/L
SEP 2004	18.57	420	358	17.6	ND (0.5)
SEP 2005	17.90	138	233	ND (90)	ND (0.5)
OCT 2006	18.28	305	231	14	ND (0.5)
SEP 2007	17.73	388	306	23.9	0.223
SEP 2008	17.14	220	63	ND (50)	0.35
SEP 2009	17.91	470	120	NA	NA
OCT 2010	19.18	359	255	NA	NA
OCT 2011	17.94	325	NA	NA	NA
OCT 2012	18.34	326	NA	NA	ND (0.24)
SEP 2013	18.15	ND(386)	NA	NA	NA
JULY 2014	15.07	283	ND(261)	NA	NA
JULY 2015	18.48	ND(347)	ND(289)	NA	NA
AUG 2016	14.98	332	ND(272)	NA	NA

AP-7189	Water Level (BTOC) (feet)	DRO µg/L	RRO µg/L	GRO µg/L	Benzene µg/L
JUN 1996	NR	9,600	NA	2,600	45
OCT 1996	NR	14,000	NA	3,400	28
SEP 1997	NR	5,900	NA	ND (34)	11
SEP 1998	NR	4,300	NA	830	ND (1)
AUG 2000	NR	4,100	NA	1,100	5.5
OCT 2001	16.65	19,100	1,300	970	9.7
OCT 2002	15.70	39,600	ND (6,060)	755	3.8
AUG 2003	14.60	45,100	2,320	712	1.9
SEP 2004	16.93	16,900	1,280	999	5.10
SEP 2005	16.15	18,600	2,330	394	3.91
OCT 2006	16.57	6,760	506	371	3.59
SEP 2007	16.09	9,410	1,500	418	2.79
SEP 2008	15.42	35,000	990	420	0.71
SEP 2009	16.26	10,000	730	NA	NA
OCT 2010	17.4	6,530	811	NA	NA
OCT 2011	16.27	8,650	NA	NA	NA
OCT 2012	16.50	18,000	NA	NA	1.9
SEP 2013	16.48	21,500	NA	NA	NA
JULY 2014	13.34	32,300	3,070	NA	NA
JULY 2015	16.82	53,600	2,960	NA	NA
AUG 2016	13.40	40,400	2,800	NA	NA

AP-7187	Water Level (BTOC) (feet)	DRO µg/L	RRO µg/L	GRO µg/L	Benzene µg/L
JUN 1996	NR	4,500	NA	3,100	29
OCT 1996	NR	4,400	NA	2,000	13
SEP 1997	NR	4,300	NA	930	9.8
SEP 1998	NR	4,600	NA	1,100	ND (5)
AUG 2000	NR	2,700	NA	600	ND (2)
OCT 2001	16.48	4,900	ND (1,100)	520	ND (0.5)
OCT 2002	15.52	31,300	ND (5,750)	350	0.6
AUG 2003	14.39	39,200	2,380	770	ND (0.5)
SEP 2004	16.73	2,840	534	122	0.160
OCT 2006	16.38	4,310	526	92.8	0.353
SEP 2007	15.92	30,600	3,780	159	ND (0.5)
SEP 2008	15.25	44,000	3,000	610	0.38
SEP 2009	16.00	9,500	730	NA	NA
OCT 2010	17.15	7,360	1,060	NA	NA
OCT 2011	16.10	10,500	1,260	NA	NA
OCT 2012	16.35	5,390	454	NA	ND (0.24)
SEP 2013	16.23	5,850	291	NA	NA
JULY 2014	13.11	28,400	3,830	NA	NA
JULY 2015	16.69	1,840	501	NA	NA
AUG 2016	13.22	20,700	2,430	NA	NA

AP-7183	Water Level (BTOC) (feet)	DRO µg/L	RRO µg/L	GRO µg/L	Benzene µg/L
JUN 1996	NR	210	NA	49	0.05
OCT 1996	NR	160	NA	ND (100)	ND (1)
SEP 1997	NR	110	NA	ND (34)	ND (1)
SEP 1998	NR	ND (250)	NA	ND (100)	ND (1)
AUG 2000	NR	65	NA	ND (100)	ND (2)
OCT 2002	16.70	ND (550)	ND (1,100)	ND (90)	ND (0.5)
AUG 2003	15.50	ND (120)	ND (190)	ND (90)	ND (0.5)
SEP 2004	17.75	96.3	302	ND (90)	ND (0.5)
SEP 2005	17.03	101	222	ND (90)	ND (0.5)
OCT 2006	17.43	94.9	284	14.7	0.181
SEP 2007	17.00	68	206	ND (100)	ND (0.5)
SEP 2008	16.38	43	54	ND (50)	ND (1)
SEP 2009	17.13	110	98	NA	NA
OCT 2010	18.22	ND(800)	219	NA	NA
OCT 2011	17.20	ND(652)	NA	NA	NA
OCT 2012	17.50	ND(388)	NA	NA	ND (0.24)
SEP 2013	17.40	ND(396)	NA	NA	NA
JULY 2014	14.12	ND(300)	ND(250)	NA	NA
JULY 2015	17.94	ND(332)	ND(202)	NA	NA
AUG 2016	14.19	175	204	NA	NA

AP-7178	Water Level (BTOC) (feet)	DRO µg/L	RRO µg/L	GRO µg/L	Benzene µg/L
JUN 1996	NR	4,500	NA	940	22
OCT 1996	NR	14,000	NA	600	19
SEP 1997	NR	3,500	NA	ND (34)	ND (0.1)
SEP 1998	NR	5,600	NA	ND (100)	ND (1)
AUG 2000	NR	2,000	NA	ND (100)	ND (2)
OCT 2001	14.90	1,900	ND (1,100)	ND (90)	ND (0.5)
OCT 2002	13.94	3,440	1,180	ND (90)	ND (0.5)
AUG 2003	12.90	50,600	6,550	ND (50)	ND (0.5)
SEP 2004	15.12	5,200	1,340	30.8	ND (0.5)
SEP 2005	14.59	4,240	941	ND (90)	0.216
OCT 2006	15.13	3,400	704	22.3	0.351
SEP 2007	14.72	7,560	1,240	18.6	ND (0.5)
SEP 2008	14.59	13,000	670	ND (50)	0.38
SEP 2009	13.90	650	120	NA	NA
OCT 2010	15.06	480	185	NA	NA
OCT 2011	14.10	80,600	NA	NA	NA
OCT 2012	14.35	1,010	NA	NA	ND (0.24)
SEP 2013	14.19	431	NA	NA	NA
JULY 2014	10.98	6,490	438	NA	NA
JULY 2015	14.62	31,500	4,060	NA	NA
AUG 2016	11.09	8,650	1,850	NA	NA

AP-6729	Water Level (BTOC) (feet)	DRO µg/L	RRO µg/L	GRO µg/L	Benzene µg/L
JUN 1996	NR	1,900	NA	50	8.9
OCT 1996	NR	3,000	NA	180	16
SEP 1997	NR	890	NA	ND (34)	ND (0.1)
SEP 1998	NR	ND (250)	NA	ND (100)	ND (1)
AUG 2000	NR	180	NA	ND (100)	ND (2)
OCT 2001	18.09	6,300	1,100	ND (90)	ND (0.5)
OCT 2002	17.14	3,550	ND (1,130)	ND (90)	ND (0.5)
AUG 2003	16.20	1,040	ND (335)	ND (90)	ND (0.5)
SEP 2004	18.31	4,440	884	40.8	ND (0.5)
SEP 2005	17.55	2,920	759	ND (90)	ND (0.5)
OCT 2006	17.98	3,330	477	41.3	0.319
SEP 2007	17.53	1,720	801	43.4	ND (0.5)
SEP 2008	16.87	550	110	0.02	0.35
SEP 2009	17.63	2,700	320	NA	NA
OCT 2010	18.82	3,270	701	NA	NA
OCT 2011	17.67	1,860	NA	NA	NA
OCT 2012	17.91	1,090	NA	NA	ND (0.24)
SEP 2013	17.91	1,950	NA	NA	NA
JULY 2014	14.61	1,430	ND(250)	NA	NA
JULY 2015	18.28	4,440	703	NA	NA
AUG 2016	14.73	2,240	381	NA	NA

EXISTING RAILROAD TRACKS

BUILDING 3563

MW3564-1

AP-7191

AP-7189

AP-7187

BUILDING 3559 (WATER WELL PUMP HOUSE)

AP-7183

AP-6729

APPROXIMATE DIRECTION OF REGIONAL GROUNDWATER FLOW

AP-7180

AP-7178

APPROXIMATE EXTENT OF CONCRETE BALLAST BURIED 12.5' TO 15' BELOW GRADE

APPROXIMATE EXTENT OF FORMER AS/SVE TREATMENT SYSTEM

FORMER BUILDING 3564

AP-7185

AP-7176

BUILDING 3565

0 20 40 80

SCALE IN FEET

ADEC Cleanup Levels in µg/L

5	Benzene
1,500	DRO
2,200	GRO
1,100	RRO

LEGEND

AP-7183 Monitoring Well

AP-7180 Monitoring Well No Longer Sampled

Water Supply Well

µg/L Micrograms per Liter

NA - Not Analyzed

ND - Not Detected (LOD)

NR - Not Reported

BTOC - Feet Below Top of Casing

DRO - Diesel-Range Organics

GRO - Gasoline-Range Organics

RRO - Residual-Range Organics

SOURCE:

CH2MHILL, FORT WAINWRIGHT GROUNDWATER SAMPLING PROGRAM 2003, OCTOBER 2003

Notes:

1. Sample data shown in RED indicate analyte concentration exceeds ADEC Cleanup Level (18 AAC 75, Table C)
2. Wells no longer sampled are shown in grayscale.
3. ADEC Cleanup levels for GRO changed from 1,300 µg/L to 2,200 µg/L in October 2008.
4. Data flags are not included on figure for clarity. Data flags are presented on Table C-2.

FAIRBANKS ENVIRONMENTAL SERVICES
3538 INTERNATIONAL STREET
FAIRBANKS, ALASKA

ALASKA DISTRICT
CORPS OF ENGINEERS
ANCHORAGE, ALASKA

Concentrations of Analytes in Groundwater at Former Building 3564

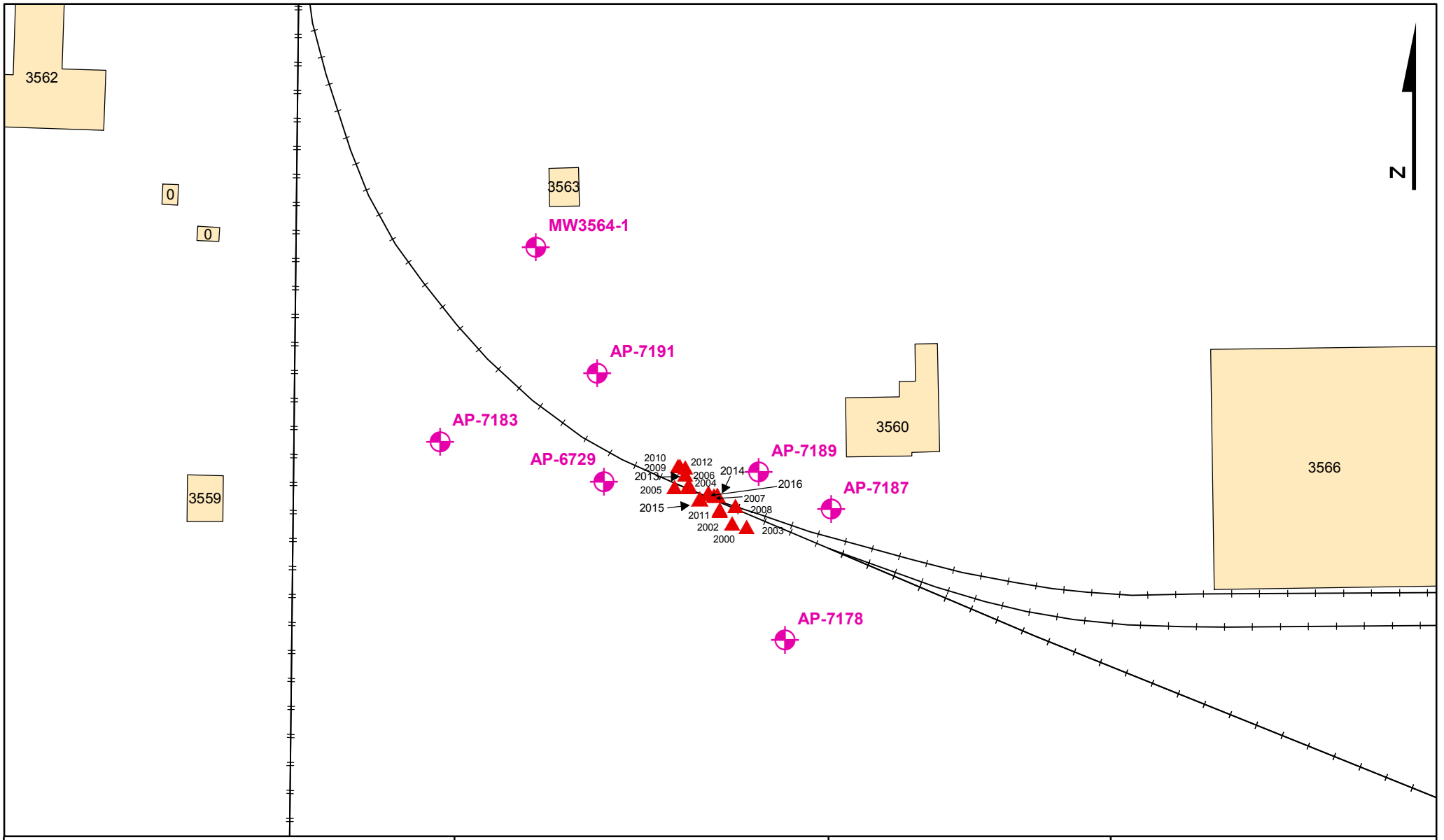
2016 Sampling Report
Two Party Sites
Fort Wainwright, Alaska

CONTRACT: W911KB-16-D-0005

FIGURE: 3-1

DATE: 5/17

3564 COC



NOTES:
1. Center of Mass Locations based on MAROS software spatial moment analysis

2. Aerial image provided by US Army, 2012

Monitoring Well

DRO Center of Mass

Railroad

Fairbanks Environmental Services
3538 International Street
Fairbanks, AK 99701

Alaska District
U.S. Army Corps of Engineers
Anchorage, AK

DRO Center of Mass at Former Building 3564

2016 Sampling Report
Two Party Sites
Fort Wainwright, Alaska

Contract: W911KB-16-D-0005	Figure: 3-4	Date: 7/17

4.0 INSTITUTIONAL CONTROL SURVEY

ICs include restrictions for unauthorized excavation and restrictions for installation of drinking water wells to prevent exposure to contaminants remaining on site at levels that are above ADEC cleanup levels (ADEC, 2016b). These ICs are maintained as part of the Fort Wainwright Land Use Controls/Institutional Controls program (FWA Garrison Policy #38)(USAGAK, 2014).

An IC survey was completed on September 9, 2016. The purpose of the IC inspection is to ensure that the IC's for Former Building 3564 are being met. The following are the site specific IC's:

- Prevent unauthorized soil disturbing activities to a depth more than six inches bgs
- Prevent installation of wells for drinking water purposes
- Prevent use of groundwater except for monitoring and remediation activities
- Protect existing monitoring wells

The IC inspection included a site visit, review of the Fort Wainwright IC geographic information system (GIS) layer, and a review of the site-specific information in the ADEC Contaminated Sites database. The results of the IC survey are presented in the 2016 Annual Institutional Controls Report (anticipated in 2017) and summarized below:

- No changes to site or adjacent land use were noted.
- The IC policy for this site is being followed
- There were no visual evidence of unauthorized on-site well installation or groundwater use, and no evidence of soil disturbing activities.

All the monitoring wells on the sites were inspected and found to be in satisfactory condition.

5.0 REFERENCES

Alaska Department of Environmental Conservation (ADEC), 2016a. *18 AAC 75 Oil and Other Hazardous Substances Pollution Control*. Revised as of January 1, 2016.

ADEC, 2016b. *Field Sampling Guidance.* March.

ADEC, 2009. *Environmental Laboratory Data and Quality Assurance Requirements.* Technical Memorandum 06-002. March.

Air Force Center for Environmental Excellence (AFCEE), 2006. *Monitoring and Remediation Optimization System (MAROS) Users Guide*: Software Version 2.2. Brooks AFB, San Antonio, TX. March.

CH2M HILL, 1997. *Intrinsic Remediation Treatability Study Report, Building 3564, Fort Wainwright, Alaska.* February

CH2M HILL, 1996. *Release Investigation Report (Phase 2) Building 3564, Fort Wainwright, Alaska.* July

Fairbanks Environmental Services (FES), anticipated in 2017. *2016 Annual Institutional Controls Report, January 1, 2016 through December 31, 2016, Fort Wainwright, Alaska.*

Fairbanks Environmental Services (FES), 2016a. *2016 Postwide Work Plan, Fort Wainwright, Alaska*. August.

FES, 2016b. *2016 UFP-QAPP – Operable Unit Sites, Fort Wainwright, Alaska.* August.

Hart Crowser, 1997.*UST Release Investigation Fort Wainwright, Alaska.* May.

Oil Spill Technology, 1994. *Underground Storage Tank Closure UST Site Assessment and Recommendations, Fort Wainwright Alaska*. October

Puls, R.W. and M. J. Barcelona, 1996.*Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures.* EPA/540/S-95/504. April.

U.S. Army, 1998. *Fort Wainwright CERCLA Federal Facility Agreement, Recommended Action, Fort Wainwright Petroleum Strategy, Fort Wainwright, Alaska.* January

U.S. Department of Defense (DoD), 2013. *Quality Systems Manual for Environmental Laboratories, Version 5.0*. July.

U.S. Environmental Protection Agency (EPA), 2005.*Roadmap to Long-Term Monitoring Optimization.EPA 542-R-05-003*. May.

U.S. Army Corps of Engineers (USACE), 2014. *Statement of Work, Environmental Investigations, Operations, and Monitoring, Various Sites, Fort Wainwright, Alaska*. 20 February, 2014; Revised, 11 March, 2014.

APPENDIX A

GROUNDWATER SAMPLING FORMS AND
GROUNDWATER FIELD MEASUREMENTS

Table A-1 -Two Party Sites Groundwater Sample Field Measurements

Well ID	Sample ID	Sample Date	Sample Time	Field Measurements							
				Water Depth (feet btoc)	Temp (°C)	Conductivity (mS/cm)	DO (mg/L)	pH	ORP (mV)	Turbidity (NTU)	Well Stabilized[1] (Y/N)
Former Building 3564											
AP-7178	16FW6406WG	8/19/2016	1410	11.94	8.67	0.704	0.26	6.39	-59.20	12.53	Y
AP-7187	16FW6405WG	8/19/2016	1300	13.30	8.82	0.670	0.39	5.88	11.30	35.22	Y
AP-7189	16FW6404WG	8/19/2016	1145	13.44	8.34	0.913	0.25	5.97	-32.9	9.67	Y
AP-6729	16FW6407WG	8/19/2016	1515	14.8	7.46	0.687	0.27	6.65	-85	56.82	Y
AP-7183	16FW6408WG	8/19/2016	1630	14.24	10.74	1.039	0.85	6.74	41.2	2.75	Y
AP-7191	16FW6402WG	8/19/2016	1030	13.93	8.97	0.818	0.3	6.61	-61.9	32.16	Y
MW3564-1	16FW6401WG	8/19/2016	915	15.00	18.17	0.651	0.34	6.89	-51.00	1.03	Y

Notes:

[1] Well stabilization as defined by ADEC Draft Field Sampling Guidance (May 2010).
Individulal parameter stabilization discrepancies and potential impact to data quality is discussed in the CDQR.

Acronyms

°C - degree Celcius
bgs - below ground surface
DO - dissolved oxygen
mg/L - milligrams per liter
mS/cm - millisiemens per centimeter
mV - millivolts
NTU - nephelomatic turbidity units
ORP - oxidation reduction potential

GROUNDWATER SAMPLE FORM FB 3564 Ft. Wainwright, Alaska

Project #: 9003-09 Site Location: 3564

Date: 8/19/16 Probe/Well #: MW3564-1

Time: 0915 Sample ID: 16FW64 01 WG

Sampler: SK

Weather: Overcast Outside Temperature: 52°F

QA/QC Sample ID/Time/LOCID: MS/MSD Performed? Yes (No)

Purge Method: Peristaltic Pump / (Submersible) / Bladder Sample Method: Peristaltic Pump / (Submersible) / Hydrasleeve / Bladder / Other

Equipment Used for Sampling: YSI # 6 Turbidity Meter #: 12 Water Level: KECK

Free Product Observed in Probe/Well? Yes (No) If Yes, Depth to Product: —

Column of Water in Probe/Well Sampling Depth 10'Screen

Total Depth in Probe/Well (feet btoc): 23.58 Well Screened (Across) / Below water table

Depth to Water from TOC (feet): - 14.98 Depth tubing / pump intake set* approx. 16 feet below top of casing

Column of Water in Probe/Well (feet): = 8.60 *Tubing/pump intake must be set approximately 2 feet below the water table for wells screened across the water table, or in the middle of the screened interval for wells screened below the water table

Circle: Gallons per foot of 1.25" (X 0.064) or 2" (X 0.163) or 4" (X 0.65)

Volume of Water in 1 Probe/Well Casing (gal): 1.4

Micropurge well/probe at a rate of 0.03 to 0.15 GPM until parameters stabilize or 3 casing volumes have been removed. If well draws down below tubing or pump intake, stop purging and sample as a low-yield well using a no-purge technique.

Field Parameters:		±3% (or ±0.2°C max)	At least 3 of the 5 parameters below must stabilize					<0.33 feet after initial drawdown
			±3%	±10% (<1mg/L, ±0.2 mg/L)	±0.1 units	±10 mV	±10% (<10NTU, ±1NTU)	
Water Removed (gal)	Time Purged (min)	Temperature (°C)	Conductivity (mS/cm)	Dissolved O_2 (mg/L)	pH	Potential (mV)	Turbidity (NTU)	Water Level (ft)
0.5	5	19.42	0.625	0.71	6.92	62.2	28.54	[redacted] 15.00
1.0	10	17.81	0638	0.54	6.68	5.6	7.33	15.00
1.5	15	17.82	0.640	0.58	6.83	-9.9	3.90	15.00
2.0	20	18.18	0.643	0.49	6.86	-26.0	3.13	15.00
2.5	25	18.29	0.646	0.39	6.91	-44.1	2.23	15.00
3.0	30	18.23	0.646	0.37	6.90	-47.3	1.89	15.00
3.5	35	18.17	0.651	0.34	6.89	-51.0	1.03	15.00

SK

Did groundwater parameters stabilize? (Yes) / No If no, why not?

Did drawdown stabilize? (Yes) / No If no, why not?

Was flowrate between 0.03 and 0.15 GPM? (Yes) No If no, why not?

Water Color: (Clear) Yellow Orange Brown/Black (Sand/Silt) Other:

Well Condition: Locked (Y) N Labeled with LOC ID (Y) / N Comments:

Sheen: Yes / (No) Odor: Yes / (No) Notes/Comments:

Laboratory Analyses (Circle): DRO, RRO, Iron, Sulfate

pH checked of samples: (Y) N Approximate volume added (mL): HCl = 0 HNO_3 = 0

Purge Water

Gallons generated: 3.5 Containerized and disposed as IDW? (Yes) / No If No, why not?

Sampler's Initials: SK Disposal method: FWA IDW treatment facility / Emerald Environmental / GAC treatment and surface discharge / other

GROUNDWATER SAMPLE FORM | **FB 3564** | **Ft. Wainwright, Alaska**

Project #: 9003-09 | Site Location: 3564

Date: 8/19/16 | Probe/Well #: AP-7191

Time: 1030 | Sample ID: 16FW64 02 WG

Sampler: SK

Weather: Overcast | Outside Temperature: 54°F

QA/QC Sample ID/Time/LOCID: 16FW6403WG / 1045 / AP-2020 | MS/MSD Performed? (Yes) No

Purge Method: Peristaltic Pump / (Submersible) / Bladder | Sample Method: Peristaltic Pump / (Submersible) / Hydrasleeve / Bladder / Other

Equipment Used for Sampling: YSI # 6 | Turbidity Meter #: 12 | Water Level: KECK

Free Product Observed in Probe/Well? Yes (No) | If Yes, Depth to Product: —

Column of Water in Probe/Well | Sampling Depth: 10' Screen

Total Depth in Probe/Well (feet btoc): 21.47 | Well Screened (Across) / Below water table

Depth to Water from TOC (feet): - 13.91 | Depth tubing / pump intake set* approx. 14.90 feet below top of casing

Column of Water in Probe/Well (feet): = 7.56 | *Tubing/pump intake must be set approximately 2 feet below the water table for wells screened across the water table, or in the middle of the screened interval for wells screened below the water table

Circle: Gallons per foot of 1.25" (X 0.064) or 2" (X 0.163) or 4" (X 0.65)

Volume of Water in 1 Probe/Well Casing (gal): 1.23

Micropurge well/probe at a rate of 0.03 to 0.15 GPM until parameters stabilize or 3 casing volumes have been removed. If well draws down below tubing or pump intake, stop purging and sample as a low-yield well using a no-purge technique.

Field Parameters:		±3% (or ±0.2°C max)	*At least 3 of the 5 parameters below must stabilize* ±3%	±10% (<1mg/L, ±0.2 mg/L)	±0.1 units	±10 mV	±10% (<10NTU, ±1NTU)	<0.33 feet after initial drawdown
Water Removed (gal)	Time Purged (min)	Temperature (°C)	Conductivity (mS/cm)	Dissolved O_2 (mg/L)	pH	Potential (mV)	Turbidity (NTU)	Water Level (ft)
0.5	5	9.17	0.713	0.66	4.86	1.2	120.3	13.93
1.0	10	8.63	0.754	0.50	6.35	-28.4	81.11	13.93
1.5	15	8.22	0.799	0.37	6.55	-38.1	56.03	13.93
2.0	20	8.04	0.807	0.37	6.58	-43.9	43.66	13.93
2.5	25	8.96	0.806	0.33	6.58	-50.6	36.81	13.93
3.0	30	8.97 ✓	0.818 ✓	0.30 ✓	6.61 ✓	-61.9 ✓	32.16 ✓	13.93

SK

Did groundwater parameters stabilize? (Yes) No If no, why not?

Did drawdown stabilize? (Yes) No If no, why not?

Was flowrate between 0.03 and 0.15 GPM? (Yes) No If no, why not?

Water Color: (Clear) Yellow Orange Brown/Black (Sand/Silt) Other:

Well Condition: Locked (Y) N Labeled with LOC ID (Y) N Comments:

Sheen: Yes (No) Odor (Yes) No Mild Notes/Comments:

Laboratory Analyses (Circle): DRO, RRO, Iron, Sulfate

pH checked of samples: (Y) N Approximate volume added (mL): HCl = 0 HNO_3 = 0

Purge Water

Gallons generated: 3.75 Containerized and disposed as IDW? (Yes) No If No, why not?

Sampler's Initials: SK Disposal method: FWA IDW treatment facility / Emerald Environmental / GAC treatment and surface discharge / other

GROUNDWATER SAMPLE FORM FB 3564 Ft. Wainwright, Alaska

Project #: 9003-09 Site Location: 3564

Date: 8/19/16 Probe/Well #: AP-7189

Time: 1145 Sample ID: 16FW6404 WG

Sampler: SK

Weather: Overcast Outside Temperature: _____

QA/QC Sample ID/Time/LOCID: _____ MS/MSD Performed? Yes/No

Purge Method: Peristaltic Pump / Submersible / Bladder Sample Method: Peristaltic Pump / Submersible / Hydrasleeve / Bladder / Other

Equipment Used for Sampling: YSI # 6 Turbidity Meter #: 12 Water Level: KECK

Free Product Observed in Probe/Well? Yes/No If Yes, Depth to Product: _____

Column of Water in Probe/Well Sampling Depth

Total Depth in Probe/Well (feet btoc): 21.85 Well Screened Across / Below water table

Depth to Water from TOC (feet): - 13.40 Depth tubing / pump intake set* approx. 14.4 feet below top of casing

Column of Water in Probe/Well (feet): = 8.45 *Tubing/pump intake must be set approximately 2 feet below the water table for wells screened across the water table, or in the middle of the screened interval for wells screened below the water table

Circle: Gallons per foot of 1.25" (X 0.064) or 2" (X 0.163) or 4" (X 0.65)

Volume of Water in 1 Probe/Well Casing (gal): 1.4

Micropurge well/probe at a rate of 0.03 to 0.15 GPM until parameters stabilize or 3 casing volumes have been removed. If well draws down below tubing or pump intake, stop purging and sample as a low-yield well using a no-purge technique.

Field Parameters:		±3% (or ±0.2°C max)	At least 3 of the 5 parameters below must stabilize: ±3%	±10% (<1mg/L, ±0.2 mg/L)	±0.1 units	±10 mV	±10% (<10NTU, ±1NTU)	<0.33 feet after initial drawdown
Water Removed (gal)	Time Purged (min)	Temperature (°C)	Conductivity (mS/cm)	Dissolved O_2 (mg/L)	pH	Potential (mV)	Turbidity (NTU)	Water Level (ft)
0.5	5	8.69	0.958	1.37	5.98	-26.7	65.97	13.44
1.0	10	9.12	0.948	0.89	5.80	-25.4	25.32	13.44
1.5	15	8.25	0.928	0.44	5.91	-29.1	15.70	13.44
2.0	20	8.28	0.924	0.36	5.90	-26.8	12.56	13.44
2.5	25	8.30	0.919	0.32	5.92	-30.2	10.04	13.44
3.0	30	8.34	0.913	0.25	5.97	-32.9	9.67	13.44

SK

Did groundwater parameters stabilize? Yes/No If no, why not? _____

Did drawdown stabilize? Yes/No If no, why not? _____

Was flowrate between 0.03 and 0.15 GPM? Yes/No If no, why not? _____

Water Color: Clear Yellow Orange Brown/Black (Sand/Silt) Other: _____

Well Condition: Locked Y/N Labeled with LOC ID Y/N Comments: _____

Sheen Yes/No Odor Yes/No strong odor Notes/Comments: foamy sheen

Laboratory Analyses (Circle): DRO, RRO, Iron, Sulfide

pH checked of samples: Y/N Approximate volume added (mL): HCl = 0 HNO_3 = 0

Purge Water

Gallons generated: 3.5 Containerized and disposed as IDW? Yes/No If No, why not? _____

Sampler's Initials: SK Disposal method: FWA IDW treatment facility / Emerald Environmental / GAC treatment and surface discharge / other

GROUNDWATER SAMPLE FORM FB 3564 Ft. Wainwright, Alaska

Project #: 9003-09 Site Location: 3564

Date: 8/19/16 Probe/Well #: AO-7187

Time: 1300 Sample ID: 16FW64 05 WG

Sampler: SK

Weather: Overcast Outside Temperature: 55 °F

QA/QC Sample ID/Time/LOCID: MS/MSD Performed? Yes/(No)

Purge Method: Peristaltic Pump / (Submersible) / Bladder Sample Method: Peristaltic Pump / (Submersible) / Hydrasleeve / Bladder / Other

Equipment Used for Sampling: YSI # 6 Turbidity Meter #: 12 Water Level: KECK

Free Product Observed in Probe/Well? Yes/(No) If Yes, Depth to Product: ~~0~~

Column of Water in Probe/Well

Total Depth in Probe/Well (feet btoc): 17.90

Depth to Water from TOC (feet): - 13.22

Column of Water in Probe/Well (feet): = 4.68

Circle: Gallons per foot of 1.25" (X 0.064) or (2" (X 0.163)) or 4" (X 0.65)

Volume of Water in 1 Probe/Well Casing (gal): 0.76

Sampling Depth

Well Screened (Across) / Below water table

Depth tubing / pump intake set* approx. 14.2 feet below top of casing

*Tubing/pump intake must be set approximately 2 feet below the water table for wells screened across the water table, or in the middle of the screened interval for wells screened below the water table

Micropurge well/probe at a rate of 0.03 to 0.15 GPM until parameters stabilize or 3 casing volumes have been removed. If well draws down below tubing or pump intake, stop purging and sample as a low-yield well using a no-purge technique.

Field Parameters:		±3% (or ±0.2°C max)	At least 3 of the 5 parameters below must stabilize					<0.33 feet after initial drawdown
			±3%	±10% (<1mg/L, ±0.2 mg/L)	±0.1 units	±10 mV	±10% (<10NTU, ±1NTU)	
Water Removed (gal)	Time Purged (min)	Temperature (°C)	Conductivity (mS/cm)	Dissolved O_2 (mg/l)	pH	Potential (mV)	Turbidity (NTU)	Water Level (ft)
0.5	5	10.27	0.679	1.65	5.75	18.8	37.74	13.30
1.0	10	8.93	0.693	0.69	5.76	17.3	41.91	13.30
1.5	15	8.49	0.658	0.45	5.79	16.1	40.04	13.30
2.0	20	9.01	0.675	0.41	5.81	14.6	37.79	13.30
2.5	25	8.93	0.674	0.40	5.84	12.9	36.43	13.30
3.0	30	8.82	0.670	0.39	5.88	11.3	35.22	13.30

SK

Did groundwater parameters stabilize? (Yes) / No If no, why not?

Did drawdown stabilize? (Yes) / No If no, why not?

Was flowrate between 0.03 and 0.15 GPM? (Yes)/No If no, why not?

Water Color: Clear (Yellow) Orange Brown/Black (Sand/Silt) Other:

Well Condition: Lock (Y) / N Labeled with LOC ID (Y) / N Comments:

Sheen (Yes) / No slight Odor (Yes) / No Notes/Comments:

Laboratory Analyses (Circle): (DRO, RRO, Iron, Sulfate)

pH checked of samples: (Y) N Approximate volume added (mL): HCl = 0 HNO_3 = 0

Purge Water

Gallons generated: 3.75 Containerized and disposed as IDW? (Yes) / No If No, why not?

Sampler's Initials: SK Disposal method: FWA IDW treatment facility / Emerald Environmental / GAC treatment and surface discharge / other

GROUNDWATER SAMPLE FORM FB 3564 Ft. Wainwright, Alaska

Project #: 9003-09 Site Location: 3564

Date: 8/19/16 Probe/Well #: AP-7178

Time: 1410 Sample ID: 16FW64 06 WG

Sampler: SK

Weather: Overcast Outside Temperature: 55°F

QA/QC Sample ID/Time/LOCID: MS/MSD Performed? Yes (No)

Purge Method: Peristaltic Pump / (Submersible) / Bladder Sample Method: Peristaltic Pump / (Submersible) / Hydrasleeve / Bladder / Other

Equipment Used for Sampling: YSI # 6 Turbidity Meter #: 12 Water Level: KECK

Free Product Observed in Probe/Well? (No) If Yes, Depth to Product: —

Column of Water in Probe/Well — Sampling Depth 10' screen

Total Depth in Probe/Well (feet btoc): 17.56

Depth to Water from TOC (feet): - 11.09

Column of Water in Probe/Well (feet): = 6.47

Circle: Gallons per foot of 1.25" (X 0.064) or 2" (X 0.163) or 4" (X 0.65)

Volume of Water in 1 Probe/Well Casing (gal): 1.0

Well Screened (Across) / Below water table

Depth tubing / pump intake set* approx. 12 feet below top of casing

*Tubing/pump intake must be set approximately 2 feet below the water table for wells screened across the water table, or in the middle of the screened interval for wells screened below the water table

Micropurge well/probe at a rate of 0.03 to 0.15 GPM until parameters stabilize or 3 casing volumes have been removed. If well draws down below tubing or pump intake, stop purging and sample as a low-yield well using a no-purge technique.

Field Parameters:		±3% (or ±0.2°C max)	At least 3 of the 5 parameters below must stabilize					<0.33 feet after initial drawdown
			±3%	±10% (<1mg/L, ±0.2 mg/L)	±0.1 units	±10 mV	±10% (<10NTU, ±1NTU)	
Water Removed (gal)	Time Purged (min)	Temperature (°C)	Conductivity (mS/cm)	Dissolved O_2 (mg/L)	pH	Potential (mV)	Turbidity (NTU)	Water Level (ft)
0.5	5	9.37	0.698	0.76	6.64	-13.5	109.8	11.53
1.0	10	8.52	0.697	0.53	6.37	-27.6	71.54	11.90
1.5	15	8.06	0.698	0.34	6.32	-44.3	38.64	11.94
2.0	20	8.24	0.701	0.31	6.35	-52.3	28.87	11.94
2.5	25	8.50	0.701	0.27	6.38	-56.9	14.03	11.94
3.0	30	8.56	0.702	0.27	6.38	-57.6	12.96	11.94
3.5	35	8.67	0.704	0.26	6.39	-59.2	12.53	11.94

SK

Did groundwater parameters stabilize? (Yes) / No If no, why not?

Did drawdown stabilize? (Yes) / No If no, why not?

Was flowrate between 0.03 and 0.15 GPM? (Yes)/No If no, why not?

Water Color: (Clear) Yellow Orange Brown/Black (Sand/Silt) Other:

Well Condition: Lock (Y) N Labeled with LOC ID (Y) N Comments:

Sheen (Yes) No Slight Odor: (Yes) No Notes/Comments:

Laboratory Analyses (Circle): (DRO, RRO) Iron, Sulfate

pH checked of samples (Y) N Approximate volume added (mL): HCl = 6 HNO_3 = 0

Purge Water

Gallons generated: 3.75 Containerized and disposed as IDW? (Yes) No If No, why not?

Sampler's Initials: SK Disposal method: FWA IDW treatment facility / Emerald Environmental / GAC treatment and surface discharge / other

GROUNDWATER SAMPLE FORM FB 3564 Ft. Wainwright, Alaska

Project #: 9003-09 Site Location: 3564

Date: 8/19/16 Probe/Well #: AP-6729

Time: 1515 Sample ID: 16FW64 07 WG

Sampler: SK

Weather: Overcast Outside Temperature: 60°F

QA/QC Sample ID/Time/LOCID: MS/MSD Performed? Yes (No)

Purge Method: Peristaltic Pump / (Submersible) / Bladder Sample Method: Peristaltic Pump / (Submersible) / Hydrasleeve / Bladder / Other

Equipment Used for Sampling: YSI # 6 Turbidity Meter #: 12 Water Level: 14.73

Free Product Observed in Probe/Well? Yes (No) If Yes, Depth to Product: —

Column of Water in Probe/Well Sampling Depth 10' screen

Total Depth in Probe/Well (feet btoc): 26.75 Well Screened Across (Below) water table

Depth to Water from TOC (feet): - 14.73 Depth tubing / pump intake set* approx. 21.75 feet below top of casing

Column of Water in Probe/Well (feet): = 12.02 *Tubing/pump intake must be set approximately 2 feet below the water table for wells screened across the water table, or in the middle of the screened interval for wells screened below the water table

Circle: Gallons per foot of 1.25" (X 0.064) or (2" (X 0.163) or 4" (X 0.65)

Volume of Water in 1 Probe/Well Casing (gal): 2.0

Micropurge well/probe at a rate of 0.03 to 0.15 GPM until parameters stabilize or 3 casing volumes have been removed. If well draws down below tubing or pump intake, stop purging and sample as a low-yield well using a no-purge technique.

Field Parameters:		±3% (or ±0.2°C max)	At least 3 of the 5 parameters below must stabilize					<0.33 feet after initial drawdown
			±3%	±10% (<1mg/L, ±0.2 mg/L)	±0.1 units	±10 mV	±10% (<10NTU, ±1NTU)	
Water Removed (gal)	Time Purged (min)	Temperature (°C)	Conductivity (mS/cm)	Dissolved O_2 (mg/L)	pH	Potential (mV)	Turbidity (NTU)	Water Level (ft)
0.5	5	9.12	0.666	0.82	6.68	-71.5	82.46	14.80
1.0	10	7.90	0.683	0.58	6.67	-70.0	89.90	14.80
1.5	15	7.58	0.693	0.43	6.65	-68.5	76.12	14.80
2.0	20	7.54	0.700	0.35	6.66	-72.4	69.08	14.80
2.5	25	7.50	0.695	0.30	6.65	-82.0	71.21	14.80
3.0	30	7.49	0.691	0.29	6.64	-84.8	59.59	14.80
3.5	35	7.46	0.687	0.27	6.65	-85.0	56.82	14.80

SK

Did groundwater parameters stabilize? (Yes) / No If no, why not?

Did drawdown stabilize? (Yes) / No If no, why not?

Was flowrate between 0.03 and 0.15 GPM? (Yes) / No If no, why not?

Water Color: (Clear) Yellow Orange Brown/Black (Sand/Silt) Other:

Well Condition: Locked (Y) / N Labeled with LOC ID: (Y) / N Comments:

Sheen: Yes / (No) Odor (Yes) / No Mild Notes/Comments:

Laboratory Analyses (Circle): DRO, RRO, ~~Iron~~, Sulfate

pH checked of samples: (Y) / N Approximate volume added (mL): HCl = 0 HNO_3 = 0

Purge Water

Gallons generated: 3.75 Containerized and disposed as IDW? (Yes) / No If No, why not?

Sampler's Initials: SK Disposal method: FWA IDW treatment facility / Emerald Environmental / GAC treatment and surface discharge / other

GROUNDWATER SAMPLE FORM FB 3564 Ft. Wainwright, Alaska

Project #: 9003-09 Site Location: 3564

Date: 8/19/16 Probe/Well #: AP-7183

Time: 1630 Sample ID: 16FW64 08 WG

Sampler: SK

Weather: Overcast Outside Temperature: 60°F

QA/QC Sample ID/Time/LOCID: MS/MSD Performed? Yes (No)

Purge Method: Peristaltic Pump / (Submersible) / Bladder Sample Method: Peristaltic Pump / (Submersible) / Hydrasleeve / Bladder / Other

Equipment Used for Sampling: YSI # 6 Turbidity Meter #: 12 Water Level: KECK

Free Product Observed in Probe/Well? Yes/(No) If Yes, Depth to Product: ~~2~~

Column of Water in Probe/Well Sampling Depth 10' screen

Total Depth in Probe/Well (feet btoc): 21.91 Well Screened (Across) / Below water table

Depth to Water from TOC (feet): - 14.19 Depth tubing / pump intake set* approx. 15.2 feet below top of casing

Column of Water in Probe/Well (feet): = 7.72 *Tubing/pump intake must be set approximately 2 feet below the water table for wells screened across the water table, or in the middle of the screened interval for wells screened below the water table

Circle: Gallons per foot of 1.25" (X 0.064) or (2" (X 0.163)) or 4" (X 0.65)

Volume of Water in 1 Probe/Well Casing (gal): 1.3

Micropurge well/probe at a rate of 0.03 to 0.15 GPM until parameters stabilize or 3 casing volumes have been removed. If well draws down below tubing or pump intake, stop purging and sample as a low-yield well using a no-purge technique.

Field Parameters:		±3% (or ±0.2°C max)	At least 3 of the 5 parameters below must stabilize					<0.33 feet after initial drawdown
			±3%	±10% (<1mg/L, ±0.2 mg/L)	±0.1 units	±10 mV	±10% (<10NTU, ±1NTU)	
Water Removed (gal)	Time Purged (min)	Temperature (°C)	Conductivity (mS/cm)	Dissolved O_2 (mg/L)	pH	Potential (mV)	Turbidity (NTU)	Water Level (ft)
0.5	5	10.70	1.152	0.88	6.84	35.7	3.93	14.24
1.0	10	10.66	1.150	0.90	6.77	38.1	3.56	14.24
1.5	15	10.68	1.047	0.93	6.74	40.0	3.20	14.24
2.0	20	10.78	1.045	0.96	6.73	40.7	2.64	14.24
2.5	25	10.74	1.039	0.85	6.74	41.2	2.75	14.24
~~3.0~~	~~30~~							

SK

Did groundwater parameters stabilize? (Yes) No If no, why not?

Did drawdown stabilize? (Yes) / No If no, why not?

Was flowrate between 0.03 and 0.15 GPM? (Yes) No If no, why not?

Water Color: (Clear) Yellow Orange Brown/Black (Sand/Silt) Other:

Well Condition: Locked (Y) / N Labeled with LOC ID (Y) / N Comments:

Sheen: Yes / (No) Odor: Yes (No) Notes/Comments:

Laboratory Analyses (Circle): (DRO, RRO, Iron, Sulfate)

pH checked of samples: (Y) / N Approximate volume added (mL): HCl = 0 HNO_3 = 0

Purge Water

Gallons generated: 2.75 Containerized and disposed as IDW? (Yes) / No If No, why not?

Sampler's Initials: SK Disposal method: FWA IDW treatment facility / Emerald Environmental / GAC treatment and surface discharge / other

GROUNDWATER SAMPLE FORM FB 3564 Ft. Wainwright, Alaska

Project #: 9003-09 Site Location: 3564

Date: 8/19/16 Probe/Well #: Rinsate 16

Time: 1245 Sample ID: 16FW64 09 WG

Sampler: JK

Weather: Overcast Outside Temperature: 60 °F

QA/QC Sample ID/Time/LOCID: MS/MSD Performed? Yes/No

Purge Method: Peristaltic Pump / Submersible / Bladder Sample Method: Peristaltic Pump / Submersible / Hydrasleeve / Bladder / Other

Equipment Used for Sampling: YSI # _____ Turbidity Meter #: _____ Water Level: _____

Free Product Observed in Probe/Well? Yes/No If Yes, Depth to Product: _____

Column of Water in Probe/Well Sampling Depth

Total Depth in Probe/Well (feet btoc): _____ Well Screened Across / Below water table

Depth to Water from TOC (feet): - _____ Depth tubing / pump intake set* approx. _____ feet below top of casing

Column of Water in Probe/Well (feet): = _____ *Tubing/pump intake must be set approximately 2 feet below the water table for wells screened across the water table, or in the middle of the screened interval for wells screened below the water table

Circle: Gallons per foot of 1.25" (X 0.064) or 2" (X 0.163) or 4" (X 0.65)

Volume of Water in 1 Probe/Well Casing (gal): _____

Micropurge well/probe at a rate of 0.03 to 0.15 GPM until parameters stabilize or 3 casing volumes have been removed. If well draws down below tubing or pump intake, stop purging and sample as a low-yield well using a no-purge technique.

Field Parameters:		±3% (or ±0.2°C max)	*At least 3 of the 5 parameters below must stabilize*					<0.33 feet after initial drawdown
			±3%	±10% (<1mg/L, ±0.2 mg/L)	±0.1 units	±10 mV	±10% (<10NTU, ±1NTU)	
Water Removed (gal)	Time Purged (min)	Temperature (°C)	Conductivity (mS/cm)	Dissolved O_2 (mg/L)	pH	Potential (mV)	Turbidity (NTU)	Water Level (ft)
		Rinsate from pump used						
		in well AP-7183						

Did groundwater parameters stabilize? Yes / No If no, why not? _____

Did drawdown stabilize? Yes / No If no, why not? _____

Was flowrate between 0.03 and 0.15 GPM? Yes/No If no, why not? _____

Water Color: Clear Yellow Orange Brown/Bleck (Sand/Silt) Other: _____

Well Condition: Lock: Y / N Labeled with LOC ID: Y / N Comments: _____

Sheen: Yes / No Odor: Yes / No Notes/Comments: _____

Laboratory Analyses (Circle): DRO, RRO, Iron, Sulfate

pH checked of samples: Y / N Approximate volume added (mL): HCl = _____ HNO_3 = _____

Purge Water

Gallons generated: _____ Containerized and disposed as IDW? Yes / No If No, why not? _____

Sampler's Initials: _____ Disposal method: FWA IDW treatment facility / Emerald Environmental / GAC treatment and surface discharge / other

APPENDIX B

CHEMICAL DATA QUALITY REVIEW AND ADEC CHECKLISTS

FINAL

CHEMICAL DATA QUALITY REVIEW

Two-Party Site (2016)

Former Building 3564

Fort Wainwright, Alaska

NPDL # 16-088

Prepared: December 16, 2016

Prepared for and Under Contract to

Army Corps of Engineers – Alaska District

Prepared by

Fairbanks Environmental Services, Inc.

I certify that all data quality review criteria described in Section 1.1 were assessed, and that qualifications were made according to the criteria outlined in the Postwide UFP-QAPP.

Vanessa Ritchie
Project Chemist

Page intentionally left blank

LIST OF ACRONYMS AND ABBREVIATIONS

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
B	analytical result is qualified as a potential high estimate due to contamination present in a blank sample
BTEX	benzene, toluene, ethylbenzene, and xylenes
°C	degrees Celsius
CDQR	Chemical Data Quality Review
COC	chain-of-custody
DL	detection limit
DoD	United States Department of Defense
DQO	data quality objective
DRO	diesel range organics
ELAP	Environmental Laboratory Accreditation Program
FES	Fairbanks Environmental Services, Inc
GRO	gasoline range organics
J	analytical result is qualified as an estimated value because the concentration is less than the LOQ
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LOD	limit of detection
LOQ	limit of quantitation
M (L,H)	analytical result qualified as a potential estimate (biased L-low or H-high) due to matrix interference
µg/L	micrograms per liter
mg/L	milligrams per liter
MS	matrix spike sample
MSD	matrix spike duplicate sample
NA	not applicable
Q (L,H)	analytical result is qualified as a potential estimate (biased L-low or H-high) due to a QC failure
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual for Environmental Laboratories
R	analytical result is rejected and is not suitable for project use
RPD	relative percent difference
RRO	residual range organics
SDG	sample data group
SGS	SGS North America, Inc.
UFP	Uniform Federal Policy

Page intentionally left blank

1.0 INTRODUCTION

This Chemical Data Quality Review (CDQR) summarizes the technical review of analytical results generated in support of groundwater sample collection at Former Building 3564 during 2016. The groundwater sampling is summarized in Section 1.3. Groundwater sample tracking and analytical results tables are presented in Appendix C.

Fairbanks Environmental Services, Inc (FES) reviewed project and quality control (QC) analytical data to assess whether the data met the designated quality objectives and were acceptable for project use. The project data were reviewed for deviations to the requirements presented in the Postwide Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP; FES, 2016), the Alaska Department of Environmental Conservation (ADEC) Technical Memo 06-002 (ADEC, 2009), and the United States Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (QSM), Version 5.0 (DoD, 2013). The review included evaluation of the following: sample collection and handling, holding times, blanks (to assess contamination), project sample and laboratory quality control sample duplicates (to assess precision), laboratory control samples (LCSs) and sample surrogate recoveries (to assess accuracy), and matrix spike sample (MS) recoveries (to assess matrix effects). Quality control deviations that do not impact data quality (e.g., high LCS recovery associated with non-detect results), are not discussed. More elaborate data quality descriptions are reported in the ADEC Laboratory Data Review Checklists, which are included at the end of Appendix B.

Groundwater sample results and limits of detection (LODs) were compared to cleanup levels presented in Title 18 of Alaska Administrative Code (AAC) Chapter 75, Table C (ADEC, 2016a).

Groundwater sample data quality is discussed in Section 2. Applicable data quality indicators are discussed for each method under separate subheadings. Data that did not meet acceptance criteria have been described and the associated samples and data quality implications or qualifications are summarized. All cited documents within the CDQR are listed in Section 3.

1.1 Analytical Methods and Data Quality Objectives

The analytical methods and associated data quality objectives (DQOs) used for this review were established in the Postwide UFP-QAPP (FES, 2016). The DQOs represent the minimum acceptable QC limits and goals for analytical measurements and are used as comparison criteria during data quality review to determine both the quality and usability of the analytical data. Table B-1 below summarizes the analytical methods employed, and the associated DQO goals, for groundwater samples.

Table B-1 – Groundwater Analytical Methods and Data Quality Objectives

Parameter	Preparation Method	Analytical Method	Limit of Detection	Precision (RPD, %)	Accuracy (%)	Completeness (%)
Diesel Range Organics (DRO)	SW3520C	AK102	0.300 mg/L	20	75-125	90
Residual Range Organics (RRO)	SW3520C	AK103	0.250 mg/L	20	60-120	90
Iron	SW3010A	SW6020A	250 µg/L	20	87-118	90
Sulfate	300.0		100 µg/L	20	90-110	90

µg/L – micrograms per liter; mg/L – milligrams per liter; RPD – relative percent difference

The six DQO categories evaluated during this review were accuracy, precision, representativeness, comparability, sensitivity, and completeness.

- *Accuracy* measures the correctness, or the closeness, between the true value and the quantity detected. It is measured by calculating the percent recovery of known concentrations of spiked compounds that were introduced into the appropriate sample matrix. Surrogate, LCS, and MS recoveries were used to measure accuracy for this project. LCS and surrogate recovery criteria are defined in the QSM.
- *Precision* measures the reproducibility of repetitive measurements. It is measured by calculating the relative percent difference (RPD) between duplicate samples. Laboratory duplicate samples, field duplicate samples, MS and matrix spike duplicate sample (MSD) pairs, and LCS and laboratory control sample duplicate (LCSD) pairs were used to measure precision for this project. Laboratory control sample/laboratory control sample duplicate (LCS/LCSD) precision criteria are defined in the QSM and field duplicate precision criteria are defined in the ADEC Laboratory Data Review Checklist (water: ≤30%).
- *Representativeness* describes the degree to which data accurately and precisely represents site characteristics. This is addressed in more detail in the following section(s).
- *Comparability* describes whether two data sets can be considered equivalent with respect to the project goal. This is addressed in more detail in the following section(s).
- *Sensitivity* describes the lowest concentration that the analytical method can reliably quantitate, and is evaluated by verifying that the detected results and/or LODs meet the project specific cleanup levels and/or screening levels.
- *Completeness* describes the amount of valid data obtained from the sampling event(s). It is calculated as the percentage of valid measurements compared to the total number of measurements. The completeness goal for this project was set at 90 percent.

In addition to these criteria for the six DQOs described above, sample collection and handling procedures and blank samples were reviewed to ensure overall data quality. Sample collection forms were reviewed to verify that representative samples were collected and samples were without headspace (if applicable). Sample handling was reviewed to assess parameters such as chain-of-custody (COC) documentation, the use of appropriate sample containers and

preservatives, shipment cooler temperature, and method-specified sample holding times. Blank samples were analyzed to detect potential field or laboratory cross-contamination. Each of these parameters contributes to the general representativeness and comparability of the project data. The combination of evaluations of the above-mentioned parameters will lead to a determination of the overall project data completeness.

1.2 Data Qualifiers

Table B-2 below outlines general flagging criteria used for this project, listed in increasing severity, to indicate QC deficiencies. Data were qualified pursuant to findings determined in the review of project data.

Table B-2 – Data Qualifier Definitions

Qualifier	Definition
ND	The analyte was analyzed for, but not detected.
J	The analyte is considered an estimated value. The analyte may be estimated due to its quantitation level (≥ DL and <LOQ), or it may signify that there is a QC deviation and the bias is unknown.
J+	The analyte is considered an estimated value with a high-bias due to a QC deviation.
J-	The analyte is considered an estimated value with a low-bias due to a QC deviation.
B	The analyte is detected in an associated blank. Result is less than 5x or 10x (for the common lab contaminants) the concentration. Therefore, the result may be high-biased.
R	Analyte result is rejected because of deficiencies in meeting QC criteria and may not be used for decision making.

1.3 Summary of Groundwater Samples

A total of eight groundwater samples, consisting of seven project samples and one field duplicate sample, were collected at the Two Party site in 2016. In addition, one MS/MSD sample for every analysis and analyte (minimum of one per 20 samples) was collected and submitted with the project samples. One equipment blank sample was collected to assess the potential for cross-contamination of the submersible pump. The submission of a trip blank sample was not required as no samples were submitted for volatile analyses. Samples were analyzed by methods presented in Table B-1.

All samples were analyzed by SGS North America Inc. (SGS) of Anchorage, Alaska. The laboratory is validated by the State of Alaska through the Contaminated Sites Program (for methods AK102, AK103, and 6020A) and the Drinking Water Program (for method 300.0). In addition, the laboratory is certified through the Environmental Laboratory Accreditation Program (ELAP) for the applicable methods employed for this project.

All samples were shipped in one sample data group (SDG) and assigned report number 1164939. A sample summary table (Table C-1) and groundwater analytical results table (Table C-2) are included in Appendix C. Groundwater sample data quality is discussed in Section 2.

2.0 GROUNDWATER SAMPLE DATA QUALITY REVIEW

This section presents the findings of the data quality review and the resulting data qualifications for groundwater samples. All samples analyzed by SGS and are included in one SDG (1164939). See the associated ADEC Laboratory Data Review Checklist for more elaborate data quality descriptions.

2.1 Sample Collection

All monitoring wells were purged and sampled with submersible pumps and groundwater sampling activities were recorded on the groundwater sample forms provided in Appendix A. Groundwater sample forms were reviewed to ensure that well drawdown and groundwater parameters met the stabilization criteria identified in the ADEC Field Sampling Guidance (ADEC, 2016b) and the UFP-QAPP (FES, 2016), that low-flow sampling criteria was employed (Puls and Barcelona, 1996), and that all groundwater levels were within the screened intervals at the time of sampling. No free product was measured, but sheen on purge water and petroleum odor was observed during sampling of wells AP-7178, 7187, and AP-7189. All samples met stabilization criteria and all water levels were within the screened interval during sample collection, with the exception noted below.

- The water level in well AP-6729 was above the screen interval during purging and sampling (sample 16FW6407WG). The water level in this area was approximately 3 feet higher than typical due to unusually high precipitation in the Fairbanks area during the summer months. Since floating product has not been previously measured in this well and the sample tubing was place within the screen interval, the impact to sample quality is negligible. No data were qualified.

An equipment blank sample was collected to evaluate the potential for submersible pump cross-contamination. Equipment blank results are further discussed in Section 2.3.

2.2 Sample Handling

The evaluation of proper sample handling procedures include verification of the following: correct COC documentation, appropriate sample containers and preservatives, cooler temperatures maintained within the ADEC-recommended temperature range (0 to 6 degrees Celsius [°C]), and sample analyses performed within method-specified holding times. No discrepancies were noted upon receipt at the laboratory.

2.3 Blanks

Method blank and equipment blank samples were utilized to assess potential cross-contamination of project samples. Method blanks assess laboratory cross-contamination and the equipment blank evaluates the potential for cross-contamination associated with wells that were sampled with non-

dedicated submersible pumps. The following paragraph outlines the analyte which was detected in the equipment blank sample.

Method Blanks

Method blank samples were analyzed in every batch, as required. No method blank contamination was noted.

Equipment Blanks

One equipment blank sample was collected to evaluate the potential for submersible pump cross-contamination. The results of equipment blank sample 16FW6409WQ were compared to results of project samples collected at the Two Party site. RRO was detected in the blank sample at a concentration (0.277mg/L) below the LOQ (0.530mg/L). RRO was detected at concentrations less than five-times that of the equipment blank in associated samples 16FW6402WG, 16FW6403WG, 16FW6407WG, and 16FW6408WG. These results were qualified (B) as potential sampling cross-contamination. Impact to the project is negligible as the detections were less than the ADEC cleanup level.

2.4 Laboratory Control Samples

The LCS/LCSD samples were prepared by adding spike compounds to blank samples in order to assess laboratory extraction and instrumentation performance. The performance of a LCS sample is a requirement for every QC batch to evaluate recovery accuracy. In addition, a LCSD is required for all Alaska fuel methods to evaluate batch precision. For QC batches that do not contain a LCSD, precision is evaluated by performing a sample duplicate, which is further discussed in Section 2.5.

All LCS and/or LCSD samples were performed, as required. The accuracy of analyte recoveries for LCS samples, and precision of the LCS/LCSD sample pair (when applicable), was evaluated. No LCS and/or LCSD accuracy or precision discrepancies were noted.

2.5 Matrix Spike Samples and Sample Duplicates

MS samples were prepared by adding spike compounds to project samples in order to assess potential matrix interference. The performance of a MS sample analysis is a requirement in every QC batch, at a minimum frequency of 1 for every 20 samples, to evaluate recovery accuracy. In addition, precision of each QC batch was evaluated by performing either a MSD sample analysis or a sample duplicate analysis and calculating the RPD. All QC batches have met these criteria, except for the batch listed below.

- Metals QC batch: MXX30164

Although potential sample matrix interference cannot be examined in the above listed QC batch, acceptable LCS recovery indicates that the analytical batch was operating within the control criteria. Moreover, this batch only contained equipment blank sample 16FW6409WQ.

For the batches containing MS/MSD samples, the accuracy and precision of the MS/MSD pair were evaluated. No accuracy or precision discrepancies were noted.

2.6 Surrogate Recovery

Surrogate compounds were added to project samples by the laboratory prior to analysis, in accordance with method requirements. Surrogate recoveries were then calculated as percentages and reported by the laboratory as a measure of analytical extraction efficiency. No surrogate recoveries were outside the established limits.

2.7 Field Duplicates

One field duplicate sample was collected and submitted to the laboratory as a blind sample during groundwater sampling activities at the Two Party site. Field duplicates were collected at a minimum frequency of 10 percent for all matrices, analytical methods, and SDGs, which meets the UFP-QAPP requirement.

Field duplicate results are summarized in Table B-3 below. In the case where a result was non-detect (ND), the LOD (presented in brackets) was used for RPD calculation purposes. If both results of the field duplicate pair were less than the LOQ (i.e., J-flagged or ND), the RPD was calculated but the results are considered an estimate and the comparison criterion is not applicable (per the UFP-QAPP). All field duplicate sample results were within the ADEC criterion of ≤30% and, therefore, are considered comparable, with the exception of RRO in field duplicate/parent sample pair 16FW6403WG/16FW6402WG. The RRO results were less than the LOQ in both samples and are considered estimated values, so no flagging was applied.

Table B-3 – Groundwater Field Duplicate Sample Results Evaluation

Analyte	Method	Primary 16FW6402WG (AP-7191)	Field Duplicate 16FW6403WG (AP-2020)	RPD, %	Comparable Criteria Met?[1]
DRO (C10 – C25)	AK102	3.95 [0.326]	3.66 [0.335]	8	YES
RRO (C25 – C36)	AK103	0.54 [0.272] J	0.385 [0.279] J	34	Not applicable
Sulfate	E300.0	7960 [1000]	7760 [1000]	3	YES
Iron	SW6020A	21100 [250]	21400 [250]	1	YES

DRO, and RRO results are in mg/L and remaining results are in µg/L.
[1] – RPD of ≤30 percent was used for evaluating water-matrix field duplicate samples.
µg/L – micrograms per liter; mg/L – milligrams per liter; RPD – relative percent difference

2.8 Additional Quality Control Discrepancies

Additional QC samples and procedures not discussed in the preceding sections of this CDQR are evaluated if deviations are noted by the laboratory in the case narratives. Additional QC samples/procedures may include, but are not limited to, instrument tuning, initial calibration verification (ICV) samples, continuing calibration verification (CCV) samples, and internal standards. No additional QC discrepancies were noted.

2.9 Analytical Sensitivity

Several project data analytes were reported above the detection limit (DL) but below the LOQ and were thus qualified as estimates due to the unknown accuracy of the analytical method at those concentrations. These data qualifications are not reported again in this CDQR, but they are noted with a "J" in the associated results table in Appendix C.

Analytical sensitivity was evaluated to verify that LODs met applicable cleanup level for non-detect results. All analytes met the analytical sensitivity requirements of the project and are acceptable for use.

2.10 Summary of Qualified Results

Overall, the review process deemed the groundwater project data acceptable for use. Several results were qualified as estimated; however, data quality impact is minor and no data were rejected pursuant to FES's data quality review.

Table B-4 below summarizes the qualified 2016 groundwater results associated with the sampling event at the Two Party site, including the associated sample numbers, analytes, and the reason for qualification.

Table B-4 – Summary of Groundwater Data Qualifications

SDG	Sample Numbers	Analytes	Qualification	Explanation
1164939	16FW6402WG 16FW6403WG 16FW6407WG 16FW6408WG	RRO	B	Equipment blank contamination

2.11 Completeness

Completeness scores were calculated for each analytical method employed for this project. Scores were obtained by assigning points to 13 different data quality categories during the review process. A maximum of 10 points was awarded for each category; points were based on the number of samples successfully meeting data quality objectives for that category. The scores were then summed to determine the total points for a method, and completeness scores were determined as follows: (total points received)/(total points possible) x 100.

A breakdown of the points received for each category and method is shown in Table B-5 below. All Two Party site data quality categories met the completeness criteria of 90 percent established in the QAPP for the sampling event. No data were rejected pursuant to the data quality review, and all data may be used, as qualified, for the purpose of the 2016 Two Party Monitoring Report.

Table B-5 – Completeness Scores for Groundwater Samples

Data Quality Category	Points DRO	Points RRO	Points Fe	Points Sulfate
Sample Collection	10	10	10	10
COC Documentation	10	10	10	10
Sample Containers/Preservation	10	10	10	10
Cooler Temperature	10	10	10	10
Holding Times	10	10	10	10
Method Blanks	10	10	10	10
Trip Blanks	NA	NA	NA	NA
Equipment Blanks	10	9	10	10
LCS/LCSD Recovery & RPD	10	10	10	10
MS/MSD Recovery & RPD	10	10	10	10
Surrogate Recovery	10	10	NA	NA
Field Duplicate	10	10	10	10
Sensitivity (DL/LOD)	10	10	10	10
Total Points Received	120	119	110	110
Total Points Possible	120	120	110	110
Percent Completeness	**100**	**99**	**100**	**100**

NA – not applicable

Page intentionally left blank

3.0 REFERENCES

Alaska Department of Environmental Conservation (ADEC), 2016a. *18 AAC 75, Oil and Other Hazardous Substances Pollution Control*. May 8.

ADEC, 2016b. *Field Sampling Guidance*. March.

ADEC, 2009. *Technical Memorandum 06-002, Environmental Laboratory Data and Quality Assurance Requirements.* March.

Department of Defense (DoD), 2013. *DoD Quality Systems Manual for Environmental Laboratories, Version 5.0.* July.

Fairbanks Environmental Services (FES), 2016. *Final Postwide Uniform Federal Policy for Quality Assurance Project Plans, Fort Wainwright, Alaska.* August.

Puls, R.W. and M. J. Barcelona, 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures.* EPA/540/S-95/504. April.

Laboratory Data Review Checklist

Completed by: Rachel James

Title: Chemist, Argon, Inc. Date: 12/07/2016

CS Report Name: Two Party Site Report Date: 09/12/2016

Consultant Firm: Fairbanks Environmental Services

Laboratory Name: SGS – Anchorage, AK Laboratory Report Number: 1164939

ADEC File Number: Bldg 3564 – 108.26.028 ADEC RecKey Number:

1. Laboratory
   a. Did an ADEC CS approved laboratory receive and perform all of the submitted sample analyses?
      ☐✓Yes ☐No ☐NA (Please explain.) Comments:

      Yes; however, EPA Method 300.0 is not listed as a CS analysis.

   b. If the samples were transferred to another "network" laboratory or sub-contracted to an alternate laboratory, was the laboratory performing the analyses ADEC CS approved?
      ☐Yes ☐No ☐✓NA (Please explain.) Comments:

      No samples were sub-contracted.

2. Chain of Custody (COC)
   a. COC information completed, signed, and dated (including released/received by)?
      ☐✓Yes ☐No ☐NA (Please explain.) Comments:

   b. Correct analyses requested?
      ☐✓Yes ☐No ☐NA (Please explain.) Comments:

3. Laboratory Sample Receipt Documentation
   a. Sample/cooler temperature documented and within range at receipt (4° ± 2° C)?
      ☐✓Yes ☐No ☐NA (Please explain.) Comments:

      All coolers arrived at the laboratory containing temperature blanks with readings within the ADEC recommended temperature range of 0° to 6°C.

b. Sample preservation acceptable – acidified waters, Methanol preserved VOC soil (GRO, BTEX, Volatile Chlorinated Solvents, etc.)?

□✓Yes No □NA (Please explain.) Comments:

c. Sample condition documented – broken, leaking (Methanol), zero headspace (VOC vials)?

□✓Yes No □NA (Please explain.) Comments:

d. If there were any discrepancies, were they documented? For example, incorrect sample containers/preservation, sample temperature outside of acceptable range, insufficient or missing samples, etc.?

□✓Yes No □NA (Please explain.) Comments:

The laboratory did not note any discrepancies.

e. Data quality or usability affected? (Please explain.)

Comments:

No data quality or usability was affected by the sample receipt documentation.

4. Case Narrative

a. Present and understandable?

□✓Yes No □NA (Please explain.) Comments:

b. Discrepancies, errors or QC failures identified by the lab?

□✓Yes No □NA (Please explain.) Comments:

The case narrative described MS/MSD exceptions discussed in 6b. It also discussed MS/MSD samples prepared from non-project parents and the recovery of analytes other than iron. These exceptions are not applicable to this project and are not reviewed in this checklist.

c. Were all corrective actions documented?

□✓Yes No □NA (Please explain.) Comments:

d. What is the effect on data quality/usability according to the case narrative?

Comments:

Case narrative does not discuss effect on data quality, it only discusses discrepancies and what was done in light of them. Any notable data quality issues mentioned in the case narrative are discussed above in 4b or elsewhere within this ADEC checklist.

5. Samples Results
   a. Correct analyses performed/reported as requested on COC?
      □✓Yes No □NA (Please explain.) Comments:

   b. All applicable holding times met?
      □✓Yes No □NA (Please explain.) Comments:

   c. All soils reported on a dry weight basis?
      □Yes No □✓NA (Please explain.) Comments:

      No soil samples were included in this work order.

   d. Are the reported PQLs less than the Cleanup Level or the minimum required detection level for the project?
      □✓Yes No □NA (Please explain.) Comments:

   e. Data quality or usability affected?
      Comments:

      Data quality or usability was not affected.

6. QC Samples
   a. Method Blank
      i. One method blank reported per matrix, analysis and 20 samples?
         □✓Yes No □NA (Please explain.) Comments:

      ii. All method blank results less than PQL?
      □ ✓Yes No □NA (Please explain.) Comments:

      No target analytes were detected in the method blank samples.

      iii. If above PQL, what samples are affected?
         Comments:

      Not applicable.

      iv. Do the affected sample(s) have data flags and if so, are the data flags clearly defined?
         □Yes No □✓NA (Please explain.) Comments:

      Qualifications were not necessary.

v. Data quality or usability affected? (Please explain.)

Comments:

No data quality or usability was affected by the method blank samples.

b. Laboratory Control Sample/Duplicate (LCS/LCSD)

i. Organics – One LCS/LCSD reported per matrix, analysis and 20 samples? (LCS/LCSD required per AK methods, LCS required per SW846)

□✓Yes No □NA (Please explain.) Comments:

ii. Metals/Inorganics – one LCS and one sample duplicate reported per matrix, analysis and 20 samples?

□✓Yes No □NA (Please explain.) Comments:

No project MS/MSD was reported in metals extraction batch MXX30164. Potential matrix interference in this batch could not be evaluated for this project; however, accuracy and precision for the batch was assessed from another client's MS/MSD sample. This batch contained iron results for equipment blank sample 16FW6409WQ.

iii. Accuracy – All percent recoveries (%R) reported and within method or laboratory limits? And project specified DQOs, if applicable. (AK Petroleum methods: AK101 60%-120%, AK102 75%-125%, AK103 60%-120%; all other analyses see the laboratory QC pages)

Yes ✓No □NA (Please explain.) Comments:

The metals MS and MSD samples prepared from 16FW6402WG contained in extraction batch MXX30143 recovered above the control limits for iron (119% and 125% vs. 87-118%). The iron spike concentration was less than the parent sample concentration, so recovery criteria were not applicable. Qualifications were not applied.

iv. Precision – All relative percent differences (RPD) reported and less than method or laboratory limits? And project specified DQOs, if applicable. RPD reported from LCS/LCSD, MS/MSD, and or sample/sample duplicate. (AK Petroleum methods 20%; all other analyses see the laboratory QC pages)

□✓Yes No □NA (Please explain.) Comments:

v. If %R or RPD is outside of acceptable limits, what samples are affected?

Comments:

See 6biii above.

vi. Do the affected sample(s) have data flags? If so, are the data flags clearly defined?

□Yes ✓No □NA (Please explain.) Comments:

Qualifications were not necessary.

vii. Data quality or usability affected? (Use comment box to explain.)
Comments:

Data quality or usability was not affected by the LCS/LCSD and MS/MSD samples.

c. Surrogates – Organics Only

i. Are surrogate recoveries reported for organic analyses – field, QC and laboratory samples?
□✓Yes No □NA (Please explain.) Comments:

ii. Accuracy – All percent recoveries (%R) reported and within method or laboratory limits? And project specified DQOs, if applicable. (AK Petroleum methods 50-150 %R; all other analyses see the laboratory report pages)
□✓Yes No □NA (Please explain.) Comments:

iii. Do the sample results with failed surrogate recoveries have data flags? If so, are the data flags clearly defined?
□Yes No □✓NA (Please explain.) Comments:

Qualifications were not necessary.

iv. Data quality or usability affected? (Use the comment box to explain.)
Comments:

Data quality or usability was not affected by the surrogates.

d. Trip blank – Volatile analyses only (GRO, BTEX, Volatile Chlorinated Solvents, etc.): <u>Water and Soil</u>

i. One trip blank reported per matrix, analysis and for each cooler containing volatile samples? (If not, enter explanation below.)
□Yes No □✓NA (Please explain.) Comments:

Volatile analyses were not included in this SDG.

ii. Is the cooler used to transport the trip blank and VOA samples clearly indicated on the COC? (If not, a comment explaining why must be entered below)
□Yes No □✓NA (Please explain.) Comments:

Volatile analyses were not included in this SDG.

iii. All results less than PQL?
□Yes No □✓NA (Please explain.) Comments:

Volatile analyses were not included in this SDG.

iv. If above PQL, what samples are affected?

Comments:

Not applicable.

v. Data quality or usability affected? (Please explain.)

Comments:

Not applicable.

e. Field Duplicate

i. One field duplicate submitted per matrix, analysis and 10 project samples?

□✓Yes No □NA (Please explain.) Comments:

One groundwater field duplicate was collected for the seven groundwater primary samples associated with this SDG.

ii. Submitted blind to lab?

□✓Yes No □NA (Please explain.) Comments:

Sample 16FW6403WG was a field duplicate of sample 16FW6402WG.

iii. Precision – All relative percent differences (RPD) less than specified DQOs? (Recommended: 30% water, 50% soil)

RPD (%) = Absolute value of: $\frac{(R_1-R_2)}{((R_1+R_2)/2)} \times 100$

Where R_1 = Sample Concentration

R_2 = Field Duplicate Concentration

□Yes ✓No □NA (Please explain.) Comments:

All results for the primary and field duplicate samples are shown in the tables below (units are mg/L for DRO and RRO and µg/L for remaining analytes). In the case where a result was detected in one sample but non-detect in the other, the LOD was used for RPD calculation purposes. The non-detect results are identified with "ND" and the LOD in brackets. In the event that both results are less than the LOQ (i.e., J-flagged or non-detect), the RPD was calculated but the comparison criterion is not applicable. Analytes that do not meet the comparison criteria are identified in gray shading and are discussed in the following paragraph. All results for the field duplicate/parent sample pair 16FW6403WG/16FW6402WG were comparable (RPD ≤ 30%) with the exception of RRO. The RRO results were less than the LOQ in both samples and considered estimated values, so no flagging was applied.

Analyte	Method	Primary 16FW6402WG (AP-7191)	Field Duplicate 16FW6403WG (AP-2020)	RPD, %	Comparable Criteria Met?
Iron	SW6020A	21100 [250]	21400 [250]	1	YES
Sulfate	E300.0	7960 [1000]	7760 [1000]	3	YES
DRO (C10 - C25)	AK102	3.95 [0.326]	3.66 [0.335]	8	YES
RRO (C25 – C36)	AK103	0.54 [0.272] J	0.385 [0.279] J	34	Not applicable

iv. Data quality or usability affected? (Use the comment box to explain why or why not.)

Comments:

No data quality or usability was affected by the field duplicates.

f. Decontamination or Equipment Blank (If not used explain why).

□✓Yes No □NA (Please explain.) Comments:

□

Equipment blank sample 16FW6409WQ was included in this work order to assess the potential for cross-contamination of the submersible pump.

i. All results less than PQL?

□✓Yes □ No □NA (Please explain.) Comments:

Target analytes were not detected in the equipment blank sample above the LOQ; however, RRO (0.277mg/L) was detected at a concentration below the LOQ (0.530mg/L). RRO was detected at concentrations less than five-times that of the equipment blank in associated samples 16FW6402WG, 16FW6403WG, 16FW6407WG, and 16FW6408WG. These results were qualified (B) as potential sampling cross-contamination. Impact to the project is negligible as the detections were less than the ADEC cleanup level.

ii. If above PQL, what samples are affected?

Comments:

See 6fi above.

iii. Data quality or usability affected? (Please explain.)

Comments:

See 6fi above.

7. Other Data Flags/Qualifiers (ACOE, AFCEE, Lab Specific, etc.)

a. Defined and appropriate?

Yes No □✓NA (Please explain.) Comments:

No other data flags/qualifiers were used.

APPENDIX C

SAMPLE SUMMARY AND ANALYTICAL RESULTS TABLES

Table C-1 Sample Summary Table
Two-Party Site - Former Building 3564
Fort Wainwright, Alaska

Sample Number	Sample Location	Sample Type	Matrix	Sampler Initials	Sample Date	Sample Time	DRO AK102	RRO AK103	Fe 6020A	SO_4 300.0	Cooler ID
Groundwater Samples											
16FW6401WG	MW3564-1	Primary	WG	JK	08/19/16	915	X	X	X	X	082201
16FW6402WG	AP-7191	Primary/MS/MSD	WG	JK	08/19/16	1030	X	X	X	X	082201
16FW6403WG	AP-2020	Field Duplicate of 16FW402WG	WG	JK	08/19/16	1045	X	X	X	X	082201
16FW6404WG	AP-7189	Primary	WG	JK	08/19/16	1145	X	X	X	X	082201
16FW6405WG	AP-7187	Primary	WG	JK	08/19/16	1300	X	X	X	X	082201
16FW6406WG	AP-7178	Primary	WG	JK	08/19/16	1410	X	X	X	X	082201
16FW6407WG	AP-6729	Primary	WG	JK	08/19/16	1515	X	X	X	X	082201
16FW6408WG	AP-7183	Primary	WG	JK	08/19/16	1630	X	X	X	X	082201
Quality Control Sample											
16FW6409WQ	RINSATE 16	Equipment Blank	WQ	JK	08/19/16	1745	X	X	X	X	082201

Notes:
All samples were submitted to SGS North America, Inc., of Anchorage, AK for analysis. All results are reported in SGS report number 1164939. The standard 21-day turnaround time was requested for all analyses. All work was performed under NPDL work order number 16-088.

DRO - diesel range organics
Fe - iron
HCl - hydrochloric acid
HDPE - high-density polyethylene
JK - Josh Klynstra
mL - millitiliter
MS/MSD - matrix spike/matrix spike duplicate
RRO - residual range organics
SO_4 - sulfate

Water Sample Collection (all samples were field-preserved at 0-6°C)
DRO/RRO - two HCl-preserved, 250 mL amber bottles
Fe - one HNO_3-preserved, 250 mL HDPE bottle, field-filtered
SO_4 - one non-preserved, 125 mL HDPE bottle

Table C-2 Groundwater Sample Results
Two-Party Site - Former Building 3564
Fort Wainwright, Alaska

			Sample ID	**16FW6401WG**	**16FW6402WG**	**16FW6403WG**	**16FW6404WG**	**16FW6405WG**	**16FW6406WG**	**16FW6407WG**	**16FW6408WG**	**16FW6409WQ**
			Location ID	MW3564-1	AP-7191	AP-2020	AP-7189	AP-7187	AP-7178	AP-6729	AP-7183	RINSATE 16
			Sample Data Group	1164939	1164939	1164939	1164939	1164939	1164939	1164939	1164939	1164939
			Laboratory ID	1164939001	1164939002	1164939005	1164939006	1164939007	1164939008	1164939009	1164939010	1164939011
			Collection Date	8/19/2016	8/19/2016	8/19/2016	8/19/2016	8/19/2016	8/19/2016	8/19/2016	8/19/2016	8/19/2016
			Matirx	WG	WG	WG	WG	WG	WG	WG	WG	WQ
			Sample Type	Primary	Primary/MS/MSD	Field Duplicate	Primary	Primary	Primary	Primary	Primary	Equipment Blank
Analyte	**Method**	**Units**	**ADEC Cleanup Level[1]**	**Result [LOD] Qualifier**	**Result [LOD] Qualifier**	**Result [LOD] Qualifier**	**Result [LOD] Qualifier**	**Result [LOD] Qualifier**	**Result [LOD] Qualifier**	**Result [LOD] Qualifier**	**Result [LOD] Qualifier**	**Result [LOD] Qualifier**
Iron	SW6020A	µg/L	NE	1590 [250]	21100 [250]	21400 [250]	42200 [250]	9420 [250]	20700 [250]	25000 [250]	ND [250]	ND [313]
Sulfate	E300.0	µg/L	NE	28000 [500]	7960 [1000]	7760 [1000]	4580 [500]	55700 [500]	10900 [500]	19600 [500]	62500 [1000]	ND [100]
Diesel Range Organics	AK102	mg/L	1.5	0.332 [0.326] J	**3.95 [0.326]**	**3.66 [0.335]**	**40.4 [0.315]**	**20.7 [0.326]**	**8.65 [0.326]**	**2.24 [0.308]**	0.175 [0.288] J	ND [0.318]
Residual Range Organics	AK103	mg/L	1.1	ND [0.272]	0.54 [0.272] J B	0.385 [0.279] J B	**2.8 [0.263]**	**2.43 [0.272]**	**1.85 [0.272]**	0.381 [0.256] J B	0.204 [0.240] J B	0.277 [0.265] J

Bolded and highlighted results exceed 2008 ADEC groundwater cleanup levels.

[1] Cleanup level established from ADEC Title 18, Alaska Administrative Code, Chapter 75.345, Table C.

Data Qualifiers:

B - result may be due to cross-contamination

J - result qualified as estimate because it is less than the LOQ

ND - not detected [LOD presented in brackets]

Acronyms:

LOD - limit of detection

LOQ - limit of quantitation

MS/MSD - matrix spike/matrix spike duplicate

µg/L - micrograms per liter

mg/L - milligrams per liter

NE - not established

WG - groundwater

APPENDIX D

MAROS ANALYSIS RESULTS

Table D-1. MAROS Statistical Analysis Summary for Former Building 3564

MAROS Statistical Trend Analysis Summary

Project: Building 3564
Location: Fort Wainwright
User Name: FES
State: Alaska

Time Period: 9/1/1998 **to** 8/19/2016
Consolidation Period: No Time Consolidation
Consolidation Type: Average
Duplicate Consolidation: Average
ND Values: Detection Limit
J Flag Values : Actual Value

Well	Source/ Tail	Number of Samples	Number of Detects	Average Conc. (mg/L)	Median Conc. (mg/L)	All Samples "ND" ?	Mann-Kendall Trend	Linear Regression Trend
PHC as DIESEL FUEL								
AP-6729	T	18	17	2.4E+00	2.1E+00	No	NT	PI
AP-7178	S	18	18	1.3E+01	4.7E+00	No	NT	NT
AP-7183	T	17	8	9.7E-02	1.0E-01	No	NT	PI
AP-7187	T	17	17	1.5E+01	7.4E+00	No	NT	NT
AP-7189	T	18	18	2.2E+01	1.8E+01	No	PI	I
AP-7191	T	16	16	2.8E+00	2.4E+00	No	I	I
MW3564-1	T	13	11	2.9E-01	3.3E-01	No	S	S

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events); No Detectable Concentration (NDC)

The Number of Samples and Number of Detects shown above are post-consolidation values.

MAROS Version 2.2, 2006, AFCEE Tuesday, September 27, 2016 Page 1 of 1

Table D-2. MAROS Spatial Moment Analysis for the Former Building 3564 Site

MAROS Spatial Moment Analysis Summary

Project: Building 3564
Location: Fort Wainwright
User Name: FES
State: Alaska

	0th Moment	1st Moment (Center of Mass)			2nd Moment (Spread)		
Effective Date	Estimated Mass (Kg)	Xc (ft)	Yc (ft)	Source Distance (ft)	Sigma XX (sq ft)	Sigma YY (sq ft)	Number of Wells
PHC as DIESEL FUEL							
10/1/2006	4.5E+00	1,382,281	3,959,998	102	1,474	1,223	7
9/1/2007	6.4E+00	1,382,285	3,959,992	91	1,491	1,202	7
9/1/2008	9.4E+00	1,382,307	3,959,986	80	1,198	1,040	7
9/1/2009	4.1E+00	1,382,276	3,960,009	114	1,557	1,382	7
10/1/2010	3.5E+00	1,382,273	3,960,010	117	1,553	1,323	7
10/1/2011	1.0E+01	1,382,297	3,959,984	83	1,353	850	7
10/1/2012	4.4E+00	1,382,278	3,960,009	114	1,541	1,449	7
9/25/2013	3.7E+00	1,382,279	3,960,004	109	1,403	1,239	7
7/7/2014	8.7E+00	1,382,287	3,959,992	90	1,405	1,196	7
7/21/2015	1.6E+01	1,382,287	3,959,990	93	1,056	921	7
8/19/2016	1.1E+01	1,382,292	3,959,993	93	1,445	1,201	7

MAROS Version 2.2, 2006, AFCEE Tuesday, September 27, 2016 Page 1 of 2

Table D-2 cont'd. MAROS Spatial Moment Analysis for WQFS Source Area

Project: Building 3564
Location: Fort Wainwright

User Name: FES
State: Alaska

Moment Type	Constituent	Coefficient of Variation	Mann-Kendall S Statistic	Confidence in Trend	Moment Trend
Zeroth Moment: Mass					
	PHC as DIESEL FUEL	0.52	15	85.9%	NT
1st Moment: Distance to Source					
	PHC as DIESEL FUEL	0.13	-1	50.0%	S
2nd Moment: Sigma XX					
	PHC as DIESEL FUEL	0.11	-11	77.7%	S
2nd Moment: Sigma YY					
	PHC as DIESEL FUEL	0.15	-9	72.9%	S

Note: The following assumptions were applied for the calculation of the Zeroth Moment:

Porosity: 0.33 **Saturated Thickness:** Uniform: 10 ft

Mann-Kendall Trend test performed on all sample events for each constituent. Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A)-Due to insufficient Data (< 4 sampling events).

Note: The Sigma XX and Sigma YY components are estimated using the given field coordinate system and then rotated to align with the estimated groundwater flow direction. Moments are not calculated for sample events with less than 6 wells.

Table D-3. MAROS First Moment Analysis Results for DRO at Former Building 3564

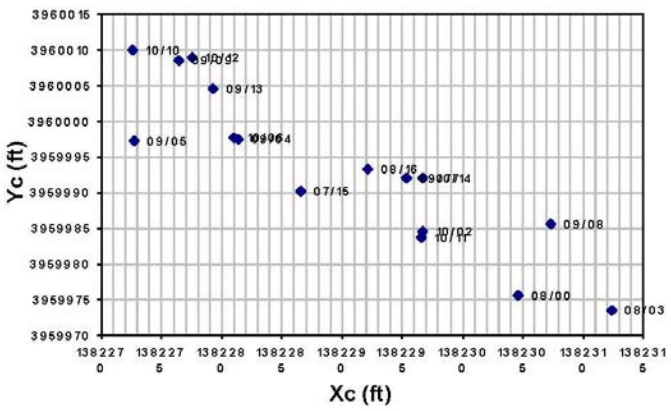
MAROS First Moment Analysis

Project: Building 3564 **User Name:** FES

Location: Fort Wainwright **State:** Alaska

COC: PHC as DIESEL FUEL

Change in Location of Center of Mass Over Time



Effective Date	Constituent	Xc (ft)	Yc (ft)	Distance from Source (ft)	Number of Wells
9/1/1998	PHC as DIESEL FUEL				5
8/1/2000	PHC as DIESEL FUEL	1,382,305	3,959,976	72	6
10/1/2001	PHC as DIESEL FUEL				4
10/1/2002	PHC as DIESEL FUEL	1,382,297	3,959,985	84	6
8/1/2003	PHC as DIESEL FUEL	1,382,312	3,959,974	67	6
9/1/2004	PHC as DIESEL FUEL	1,382,281	3,959,997	102	7
9/1/2005	PHC as DIESEL FUEL	1,382,273	3,959,997	107	6
10/1/2006	PHC as DIESEL FUEL	1,382,281	3,959,998	102	7
9/1/2007	PHC as DIESEL FUEL	1,382,295	3,959,992	91	7
9/1/2008	PHC as DIESEL FUEL	1,382,307	3,959,986	80	7
9/1/2009	PHC as DIESEL FUEL	1,382,276	3,960,009	114	7
10/1/2010	PHC as DIESEL FUEL	1,382,273	3,960,010	117	7
10/1/2011	PHC as DIESEL FUEL	1,382,297	3,959,984	83	7
10/1/2012	PHC as DIESEL FUEL	1,382,278	3,960,009	114	7
9/25/2013	PHC as DIESEL FUEL	1,382,279	3,960,004	109	7
7/7/2014	PHC as DIESEL FUEL	1,382,297	3,959,992	90	7
7/21/2015	PHC as DIESEL FUEL	1,382,287	3,959,990	93	7
8/19/2016	PHC as DIESEL FUEL	1,382,292	3,959,993	93	7

Note: Increasing (I); Probably Increasing (PI); Stable (S); Probably Decreasing (PD); Decreasing (D); No Trend (NT); Not Applicable (N/A) - Due to insufficient Data (< 4 sampling events). Moments are not calculated for sample events with less than 6 wells.

MAROS Version 2.2, 2006, AFCEE 9/27/2016 Page 1 of 1

Table D-4. MAROS Sampling Frequency Optimization Results for the Former Building 3564

MAROS Sampling Frequency Optimization Results

Project: Building 3564 **User Name:** FES

Location: Fort Wainwright **State:** Alaska

The Overall Number of Sampling Events: 11

"Recent Period" defined by events: **From** Sample Event 4 (9/1/1998) **To** Sample Event 21 (8/19/2016)

"Rate of Change" parameters used:

Constituent	Cleanup Goal	Low Rate	Medium Rate	High Rate
PHC as DIESEL FUEL	1.5	0.75	1.5	3

Units: Cleanup Goal is in mg/L; all rate parameters are in mg/L/year.

Well	Recommended Sampling Frequency	Frequency Based on Recent Data	Frequency Based on Overall Data
PHC as DIESEL FUEL			
AP-6729	Annual	Annual	Annual
AP-7178	Annual	Annual	Annual
AP-7183	Biennial	Annual	Annual
AP-7187	Annual	Annual	Annual
AP-7189	Quarterly	Quarterly	Quarterly
AP-7191	Annual	Annual	Annual
MW3564-1	Biennial	Annual	Annual

Note: Sampling frequency is determined considering both recent and overall concentration trends. Sampling Frequency is the final recommendation; Frequency Based on Recent Data is the frequency determined using recent (short) period of monitoring data; Frequency Based on Overall Data is the frequency determined using overall (long) period of monitoring data. If the "recent period" is defined using a different series of sampling events, the results could be different.

MAROS Version 2.2, 2006, AFCEE Tuesday, September 27, 2016 Page 1 of 1

COMMENTS

THE STATE of ALASKA
GOVERNOR BILL WALKER

Department of Environmental Conservation

DIVISION OF SPILL PREVENTION AND RESPONSE
Contaminated Sites Program

610 University Ave.
Fairbanks, Alaska 99709-3643
Main: 907.451.2180
Fax: 907.451.5105

File: 108.26.028

July 13, 2017

Dept. of the Army
Directorate of Public Works
Attn: IMPC-FWA-PWE (Adams)
1060 Gaffney Rd, #4500
Fort Wainwright, Alaska 99703-4500

Re: DEC approval for the 2016 Sampling Report Two-Party Site Former Building 3564, Fort Wainwright, Alaska.

Dear Mr. Adams:

On May 2, 2017 the Alaska Department of Environmental Conservation (DEC) received a draft of the above referenced document. The report presents results of the groundwater sampling event conducted at the Two-Party site, Former Building 3564, on Fort Wainwright, Alaska during August 2016. The work was conducted in general accordance with the 2016 Postwide Work Plan (FES, 2016a), the Postwide Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP; FES, 2016b), and the Statement of Work (SOW) (USACE, 2015). The report makes recommendations for continued monitoring of the wells in 2017 for analysis of DRO and RRO.

DEC provided comments for the draft document on May 11, 2017. The Army provided a response to comments on June 20, 2017. DEC is accepting the Army responses and has no further comments or concerns for the report. Therefore the 2016 Sampling Report Two-Party Site Former Building 3564, Fort Wainwright, Alaska is approved. Please provide an electronic final version of the report for the DEC public record.

If you have any questions, please do not hesitate to contact me at (907) 451-2180, or by email at dennis.shepard@alaska.gov.

Sincerely,

Environmental Program Specialist

Enclosure: Accepted RTC.

cc: Sandra Halstead, EPA, via e-mail
Kristina Smith, FWA ENVR, via email
Bob Hazlett, USACE, via e-mail
Cheryl Churchman, AEC, via email
Eric Breitenberger, DEC, via email

REVIEW COMMENTS

PROJECT: Fort Wainwright

DOCUMENT: Draft 2016 Sampling Report Two-Party Site Former Building 3564

U.S. Army	**DATE: May 11, 2017** **REVIEWER: Dennis Shepard** **PHONE: 907-451-2180**	**Action taken on comment by:**

Item No.	**Drawing Sheet No., Spec. Para.**	**COMMENTS**	**REVIEW CONFERENCE** **A – accepted** **D – disagree** **N - noted** **P - pending** **W - withdrawn**	**ARMY RESPONSE**	**ADEC/EPA RESPONSE ACCEPTANCE (A-AGREE) (D-DISAGREE)**	**ARMY RESPONSE**
1	Table 1-1 and Figure 3-1	Please ensure cleanup levels referenced throughout the document reflect current 18 AAC 75.345 levels promulgated November 2016	Noted	Table C-2 provides a comparison of the 2016 sample results and the new and previous ADEC CUL's. The Army is currently evaluating the application of the new ADEC cleanup levels for the site. The 2017 Monitoring Report will reflect the appropriate changes.	A	
2	Section 5	Please update the References to reflect current versions of documents listed, including updating the 18 AAC 75 revision reference to November 2016 and removing "Draft" from the Field Sampling Guidance.	Noted and A	The Army is currently evaluating the application of the new ADEC cleanup levels for the site. The 2017 Monitoring Report will reflect the appropriate changes. "Draft" will be removed from the Field Sampling Guidance.	A	

REVIEW COMMENTS | **PROJECT: Two-Party Site Former Bldg 3564** | **DOCUMENT: Preliminary Draft 2016 Monitoring Report** | **Location: Fort Wainwright , Alaska**

U.S. ARMY CORPS OF ENGINEERS	**DATE: March 2017** **REVIEWER: Jordan** **PHONE: 907-753-2647**	**Action taken on comment by:**

Item No.	Drawing Sheet No., Spec. Para.	COMMENTS	REVIEW CONFERENCE A - comment accepted W - comment withdrawn (if neither, explain)	CONTRACTOR RESPONSE	USAED/ADEC RESPONSE ACCEPTANCE (A-AGREE) (D-DISAGREE)
1.	Figure 3-1	The qualifiers should accompany the result wherever the result is shown in the report. Please include the qualifiers from the blank contamination to the select 2016 RRO results in this figure and check the rest of the report. J qualifiers should also be shown and a note indicating that results prior to 2016 may be qualified but the qualifiers weren't added to the figure.	Noted	For clarity, data flags are not included on Figures. However, a note will be added to the legend of Figure 3-1 directing the reader to the Tables where data flags can be found.	
		--- End of Comments ---			

COVER LETTER